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THE IMPLICATIONS OF PRESIDENT JOHNSON'S MEMORANDA OF SEPTEMBER 13 AND 14, 1965, FOR THE FUNDING OF ACADEMIC RESEARCH BY FEDERAL AGENCIES

PART I

by

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Under the Direction of

MICHAEL O. SAWYER

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ABSTRACT OF STUDY

The purpose of this study is to analyze the implications of President Johnson's Memoranda of September 13 and 14, 1965, for the funding of academic research by federal agencies. The Memoranda direct federal departments and agencies to administer university research programs to maintain existing centers of excellence, to assist institutions with demonstrated potential to become centers of excellence, and to award grants and contracts, when consistent with an agency's mission, to institutions not heavily engaged in federal research programs. The Memoranda also state that more support should be provided under terms which give the university and investigator wider scope for inquiry, as contrasted with highly specific, narrowly defined projects.

The significance of the President's Memoranda arises from the context in which they were issued. As of 1965, federal research funds were a major component of the income of universities and colleges in the United States. In 1964, all federal funds composed about 22.4 percent of university and college income in the United States. From 80 to 90 percent of total federal funds were for research and related purposes. Of the 2,237 institutions of higher education in the United States,

1,458 received some federal support. Of these 1,458 institutions, 565 received support for research. However, 100 universities and colleges received 77.4 percent of total federal support, while the same 100 institutions received 85.4 percent of support for research and related purposes. Federal support, particularly research support, was generally concentrated geographically as well as institutionally.

The existing distribution patterns have resulted from the legal and administrative decision-making patterns used by agencies to fund university research. Four basic patterns have been developed: (1) the land grant institution-agriculture research funding system; (2) a modified procurement contract system; (3) a project grant system, and (4) a system of grants to institutions. As of 1965 most funds were administered through the project grant system. In this system, formal or informal groups of science advisors heavily influence the decisions on the allocation of funds to specific researchers and institutions. The project system is basically designed to obtain information relevant to the performance of an agency's mission or to the advancement of a scientific discipline.

The project system is not designed to promote the development of research institutions, to promote the use of research as an educational tool, or to allocate funds by geographical criteria designed to measure the social and economic needs of states and regions for research institutions or for research relevant to social and economic problems.

The existing distribution pattern has generated demands for changes in research funding policies and procedures. These demands have been organized and given expression by several congressional committees. These demands have taken four basic forms: (1) the demand for greater responsibility in the administration of funds; (2) the demand for a wider distribution of funds; (3) the demand for the use of educational criteria in the administration of funds, and (4) the demand for greater efforts to direct research to social and economic needs.

The President's Memoranda partially meet these demands in that they direct agencies to effect a wider distribution of funds, and to support institutions as institutions, while giving institutions some decision-making authority over the exact research undertaken.

However, the Memoranda do not fully meet the demands that have been expressed by Congress, and the problems underlying these demands. The President's Memoranda are basically an extension of existing policies, rather than an attempt to institute new policies. There is a need for a new policy in which a distinction is made between funding of research on the basis of scientific merit, and funding of research on the basis of educational, economic, and social need.

Dedicated to

SARA

and to

MY MOTHER AND FATHER

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LIST OF DEFINITIONS

1. The definitions of "research," "basic research," "applied research," and "development" used in this study are those developed by the National Science Foundation.[1]

   These definitions are as follows:

   > Research is systematic, intensive study directed toward fuller knowledge of the subject studied. . . . Basic research is directed toward increase of knowledge. . . . Applied research is directed toward practical applications of knowledge. . . . Development is the systematic use of knowledge directed toward the design and production of useful prototypes, materials, devices, systems, methods, or processes.[2]

2. The term "academic research" in this study is used to refer to any type of research performed in a university or college or related contract center. Where relevant, the distinction between academic basic research and academic applied research is made in the text. The term "academic research" does not include development.

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[1] See National Science Foundation, Methodology of Statistics on Research and Development (Washington: U.S. Government Printing Office, 1959).

[2] Ibid., p. 110.

INTRODUCTION

Purpose

This study has two immediate purposes. The first is to discover, review, and examine selected aspects of the policies and procedures pursued by federal agencies in funding academic research, with particular emphasis on the period 1960 to 1965. The second is to analyze the implications of demands for changes in these policies and procedures as these demands are expressed in President Johnson's Memoranda of September 13 and 14, 1965.[1]

The ultimate purpose of this study is to contribute to an understanding of some of the basic issues that have been and will be involved in the funding of academic research by federal agencies in the 1960's and 1970's, and to suggest how some of these issues may be resolved.

Scope and Method

The scope of this study is limited to those aspects of the policies and procedures of federal agencies that have generated the demands for change exemplified in President

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[1] These Memoranda are reproduced in the Appendix of this study.

Johnson's Memoranda of September 14 and 15, 1965, which direct agencies to allocate research funds to more institutions than in the past, and to provide broader forms of support to researchers and institutions. The President's Memoranda apply in varying degrees to the practices of all agencies, with the exception of the funding of agricultural research by the Department of Agriculture through the experiment station system. The reasons why the experiment station system is a special case are discussed in Chapter III below. While funding practices vary widely from agency to agency, there are certain regularities in the performances of all agencies, such as the heavy concentration of funds in a limited number of institutions, that have generated the demands reflected in the President's Mamoranda. This study concentrates on the similarities in agency practices that have induced these demands. These similarities are analyzed in Chapter III. The demands for change are analyzed in Chapter IV.

The methods of this study are derived from public law. For purposes of this study the term "public law" refers to the study of values arrived at through judicial,

political, and administrative processes as these values are expressed in constitutions, statutes, court decisions, and administrative action. The set of abstractions used in public law analysis directs attention to both the substantive values aimed at through governmental processes, and the procedures designed to realize these values.

There are two reasons for analyzing the academic research policies and procedures of federal agencies as these are affected by the President's Memoranda, from the perspective of public law in the 1960's. The first reason is that in the 1960's substantial conflict has developed over the values that should be pursued through federal academic research programs. This study analyzes the basic issues in this conflict. The second reason is directly related to the first. Conflict also has developed over the procedures that should be used by federal agencies in funding academic research. This conflict may be the most important aspect of the conflict over values because the procedures used in funding research tend to determine the values that are realized in action. This study is directed in part to an analysis of the implications of the use of

alternative procedures by federal agencies in funding academic research.

The following studies constitute the foundation on which the present study is based: Vannevar Bush, Science, the Endless Frontier, 1945; National Science Foundation, Government-University Relationships in Federally Sponsored Scientific Research and Development, 1958; Charles V. Kidd, American Universities and Federal Research, 1959; President's Science Advisory Committee, Scientific Progress, the Universities, and the Federal Government, 1960; Harold Orlans, The Effects of Federal Programs on Higher Education, 1962; National Academy of Sciences, Federal Support of Basic Research in Institutions of Higher Learning, 1964; National Academy of Sciences, Basic Research and National Goals, 1965; and Bureau of the Budget, The Administration of Government Supported Research at Universities, 1966.

The present study is similar to these studies in that it is directed to an analysis of agency-university research relationships. The present study is different from these studies in that it is explicitly directed to

an analysis of the demands that have been made for changes in agency policies and procedures in the 1960's as these demands are expressed in President Johnson's Memoranda, and in that it is directed to an assessment of various possibilities for the resolution of these demands.

This study is based primarily on an analysis of statutes, agency documents, congressional hearings and reports, and other published information. The analysis of public documents was supplemented by interviews with members of federal agencies, congressional committees, and other organizations interested in federal-university research relationships. The interviews were designed primarily to secure information about the administration of agency research programs when such information was not otherwise available. Reference to any unpublished information is detailed in the footnotes.

The Argument of This Study

The basic argument of this study is that the effects of the policies and procedures pursued in the funding of academic research since 1945 have generated

significant political demands for changes in these policies and procedures, and that the President's Memoranda are one significant expression of these demands. The changes signified by these demands are as follows.

Federal academic research policies in 1966 are basically oriented to the realization of two sets of objectives. The first set of objectives is to secure information of immediate or potential use to federal agencies in the performances of their missions: national security in the case of the Department of Defense (DOD), atomic energy development in the case of the Atomic Energy Commission (AEC), aeronautical and space science and applications in the case of the National Aeronautics and Space Administration (NASA), and biometical research development in the case of the National Institutes of Health (NIH). In these instances the public is the ultimate, rather than the immediate, beneficiary of the results produced by research. The major agencies are the consumers and users of university services. While some scientists and some universities have benefited from the funds received, from the perspective of the agencies, the universities and scientists have been instruments for the

realization of immediate governmental ends.

The second set of objectives is the investment in basic research as a form of social capital with a long range potential for practical use. To an indeterminate extent, all major research funding agencies pursue this investment policy. The National Science Foundation does so explicitly, as provided by law. The other agencies do so implicitly as a matter of administrative policy. However, NSF is the only agency explicitly charged by law to strengthen American science and science education per se. In this pattern of support, the public also is the ultimate, rather than the immediate, beneficiary of the results of the research conducted.

The demands expressed in the 1960's portend the recognition of a third set of objectives in the funding of academic research, the direct satisfaction of immediate social needs. The most important of these social needs are the strengthening of higher education in the United States, the encouragement of regional economic growth, and the resolution of problems associated with urban development and environmental control. These demands

signify the partial convergence of federal policies for research, higher education, regional economic development, and urban development and environmental control. Thus far these various policies have been for the most part developed and administered as separate matters. The evidence indicates that some effort is being and will be made to bring these policies into a consistent relationship with each other, both in Congress and the executive branch.

These incipient changes in policy portend significant changes in the legal structures and patterns used to fund academic research. Two basic patterns have been used to fund academic research in the past. The first pattern, which may be called the pattern of traditional federalism, is the pattern of the grant-in-aid to the states used by the Department of Agriculture and the Office of Education in the land grant-agricultural research system. In the second pattern, which may be called the pattern of national localism, agencies at the national level directly enter into contracts with and make grants to individual scientists at the local level.

In this pattern the states and universities as

institutions generally are bypassed. This pattern of funding academic research, which has largely evolved since World War II, has some parallels in other areas of federal activity, such as direct grants to local governmental units. In the pattern of national localism, the federal government through the provision of funds directly effects an innovation in an activity that traditionally has been the province of state and local governments, or of private associations and individuals. The rise of organized research as a major activity of universities and colleges in the United States is directly attributable to the innovative role of federal agencies, although some research has been and still is funded from other sources. However, from 75 to 90 percent of academic research is paid for by federal funds, depending on the figures used for analytical purposes.

The funding of academic research by federal agencies constitutes a massive shift in policy innovation in the American governmental system from state, local, and private responsibility for an important aspect of higher education, to the assumption of responsibility at the federal level. It also indicates a shift from a

multicentered political system for the funding of research and related educational activities towards a single-centered system, although the federal agency system is itself a multicentered system in the sense that many agencies are involved.

The pattern of national localism for funding academic research evolved out of the policies of funding research as a means to the realization of agency missions, and as a form of national investment. This pattern has resulted in the extension of the arena of competition among universities and colleges for funds from state, local, and private sources to federal agencies and Congress.

In the third pattern that is emerging out of this competition, a pattern that may be called national regionalism, the focus is neither on the state as an administrative unit, nor on the individual researcher as a producer of intellectual products of value to federal agencies. The focus is on universities and colleges as regional resources for research and for educational, economic, and urban development and environmental control purposes. This pattern probably will supplement rather than replace the other existing patterns. This pattern is evident in an embryonic form

in NSF's university and college development programs, which emphasize the university and college as a regional research and educational resource; in HEW and particularly NIH programs which emphasize the regional aspects of medical research and its applications; in AEC and NASA activities which promote the use of major research installations as regional research and educational resources; in the Office of Education's community research and training programs; in the technology transfer programs of the Department of Commerce and NASA, and in the activities of other agencies. The definitions of "region" vary with the nature and purposes of the programs involved. However, for purposes of collecting and analyzing data, and perhaps for creating some consistency in the various programs, the tendency will be to use the regional classifications developed by the Bureau of the Census. This pattern is basically a response to several post-World War II trends in American society, particularly: (1) the continuing shift in the American economy from a production orientation toward a service and idea orientation, with the attendant emphasis on advanced training and on the importance of service and idea

industries to regional economic and social development, such as electronics, medicine, education, financing, insurance, and publishing and printing; (2) the continuing urbanization of the United States and the persistence of social and environmental problems associated with this phenomenon; and (3) a continuing rise in both the absolute and proportionate numbers of high school graduates who go on to college, and a continuing rise in the number of students who pursue advanced degrees.

The pattern of national regionalism in funding academic research may coincide in the 1970's and thereafter with the development, in other areas of governmental activity, of a decentralized national government organized for certain purposes along regional lines. Such a decentralized pattern of national administration may be developed as an alternative to traditional federalism in which, in theory, a major role in policy innovation is left to the states. In the pattern of decentralized national government, policy innovation will be exercised at the national level in conjunction with the assignment of decision-making authority, within broad guidelines, to local agents to administer policies to meet

regional needs.

Such a pattern appears to be developing in the funding of academic research. The basic trend is away from the exercise of decision-making authority over the allocation of academic research funds by scientists through national networks of advisory boards, in conjunction with agency personnel, through the legal powers of agencies to allocate funds. The trend is towards a greater exercise of authority over the allocation of funds by Congress through laws which stipulate that funds should be allocated on a regional or state basis, on the one hand, and towards the assignment of decision-making authority over the exact research undertaken to universities within guidelines established by Congress and the agencies, on the other hand.

The development of a national regional pattern of funding academic research may result in greater stability in federal support of research and related educational processes. In the national-local pattern, funding has tended to fluctuate in relation to variations in the appropriations and in the missions of the major agencies. The pattern of support has been an unstable one. It has created uncertainty

over the future availability of funds, and confusion over the sources of available funds. The key to success in the system for university researchers and university administrative personnel has been knowledge of the shifts in agency programs, policies, personnel, and appropriations. The system has maximized the importance of personal contacts, and the ability to negotiate and bargain through the complex network of scientists and agency personnel involved in the funding of research.

Universities as institutions have not been generally represented in the system, nor have they been recognized, except in limited cases, as the appropriate parties to receive research funds. The embryonic development of a national-regional pattern, with an emphasis on universities as a regional resource, indicates an outright recognition of universities as appropriate recipients of funds, and of university representatives as appropriate parties in interest in the formulation and administration of academic research programs. The evidence indicates that Congress is moving towards the adoption of criteria which will recognize the support of universities through research programs

as an end in itself, as well as a means to other ends, and will adopt criteria that will ensure widespread institutional participation in federal academic research and related programs.

It is evident that the meaning of the term "research," which in any case is difficult to define in an operational way, may be expanded almost beyond recognition. The underlying tendency is towards the provision of universities with general funds for operating expenses, or towards outright aid to education. However, there are strong reasons why the label "research" or the more general term "academic science" may be retained to indicate the obligation of the university to conduct inquiries and training in broad general areas of social relevance. The first reason is that direct aid would raise church-state problems under the First Amendment. The second reason is that in the past it has been easier to get appropriations for research programs than for aid to higher education programs, although this may be changing. The last reason is that the limitation of funds to research and related educational purposes will enable federal agencies to exercise policy innovation in relation to research, and

to direct research towards matters of national concern, while leaving the funding of the housekeeping responsibilities of universities to states and private sources of funds.

There are two paradoxes in the trend towards reliance on broader forms of support. The first paradox is that arguments in favor of broader forms of support constitute almost a complete reversal of the traditional argument that the independence and integrity of universities can best be protected by limiting federal support to special purpose programs.

The dominant argument in the 1960's is that universities have been so drastically affected by federal special purpose programs that there is a critical need for unrestricted federal funds to enable institutions to retain their independence and restore control over their own development, as well as meet additional costs created by rising enrollments and other factors. The second paradox is that the movement to apply science to social needs through support of academic research may lead to an emphasis on permitting universities and local scientists to make the decisions, within broadly designated areas, on what research may be relevant to the development of a given institution and region.

It will become increasingly important in the future to distinguish between the provision of funds for actual research purposes, and the provision of funds for other purposes, such as the improvement of educational processes and the encouragement of regional economic development. There is a critical need to devise funding systems appropriate to the objective sought, rather than to overburden the existing research funding system, which was not designed to achieve politically determined objectives other than the support of research on a merit basis.

The argument of this study is developed through an analysis in Chapter I of the President's Memoranda and the issues to which they are directed, an analysis of the formal structure of the federal academic research system and its impact on the financial structure of higher education in the United States in Chapter II, and analysis of the basic decision-making patterns used in the federal academic research funding system in Chapter III, an analysis of demands for changes in the system in Chapter IV, and an analysis of alternative possibilities for change in Chapter V.

CHAPTER I

THE PRESIDENT'S MEMORANDA OF SEPTEMBER 13 AND 14, 1965, AND THE ISSUES TO WHICH THEY ARE DIRECTED

The Content of the Memoranda

On September 13, 1965, President Johnson issued to the heads of all federal departments and agencies a memorandum entitled, "Strengthening Academic Capability for Science Throughout the Country." On September 14, the Office of the White House Press Secretary released another document entitled "Statement of the President to the Cabinet on Strengthening the Academic Capability for Science Throughout the Nation."[1] These documents originated in the Office of Science and Technology, one of the functions of which is to advise the President on broad matters of national research policy.

In a press briefing on these documents, the President's Special Assistant for Science and Technology, Donald Hornig, emphasized that the documents are intended to express a new policy for the Executive Branch for the funding of academic research by federal agencies.[2]

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[1] These documents are reprinted in the Appendix of this study.

[2] For an account of this press briefing, see Daniel S. Greenberg, "LBJ Directive: He Says Spread the Research Money," Science, CXLIX, No. 3691 (September 24, 1965), 1483.

As expressed in the September 14 Memorandum, the basic purpose of the new policy is "to insure that our programs for Federal support of research in colleges and universities contribute more to the long run strengthening of the universities and colleges so that these institutions can best serve the nation in the years ahead." According to the figures used in the Memoranda, of the $15 billion that the federal government spent on research and development in 1964, about $1.3 billion, or 9 percent, were spent in universities and colleges. The National Institutes of Health provided about 34 percent of the $1.3 billion, the Department of Defense about 23 percent, the National Science Foundation about 13 percent, and the National Aeronautics and Space Administration about 9 percent. Funds provided by federal agencies constituted at least 70 percent of the total research expenditures of all American universities and colleges in 1964. The September 13 Memorandum states: "Plainly the Federal expenditures have a major effect on the development of our higher educational system." After stressing the proposition that at the university level research and education are inseparable, the Memorandum

directs all departments and agencies to support research not only to secure information for the performance of immediate missions, but also to strengthen academic institutions and to increase the number of institutions capable of performing research of high quality.

The September 13 Memorandum directs all agencies to fashion programs designed to maintain existing centers of excellence, to assist institutions with demonstrated potential to become centers of excellence, and to award grants and contracts, when consistent with the agency's mission, to institutions not heavily engaged in federal research programs. In a particular reference to the terms and conditions under which research funds should be provided to universities, the Memoranda state that "More support will be provided under terms which give the university and the investigator wider scope for inquiry, as contrasted with highly specific, narrowly defined projects."

The President's Memoranda had an immediate impact on the Committee on Academic Science and Engineering (CASE), organized in the summer and fall of 1965 under the aegis of the Federal Council of Science and Technology.

The committee, which is composed of representatives of the major research funding agencies, held its first meeting on September 30, 1965, about two weeks after the release of the President's Memoranda.[1] At the meeting, the President's Science Advisor, Donald Hornig, stated that the Memoranda present urgent problems to all agencies involved in funding academic research. After some discussion of the President's Memoranda, the members of the committee agreed to assume responsibility for the submission of monthly reports to the committee's staff, setting forth in detail information on the funds distributed by each agency to educational institutions, including information on the types of programs used, the identities of institutions and individuals receiving funds, the geographical patterns exemplified in the

[1] The meeting was attended by Dr. Leland J. Haworth, Director of the National Science Foundation, as chairman; the President's Science Advisor, Dr. Donald Hornig (ex officio); Dr. Ernest Allen of the Public Health Service; Dr. Spofford English of the Atomic Energy Commission; Dr. Ellis A. Johnson of the Department of Health, Education, and Welfare; Peter Muirhead of the Office of Education; Dr. Randall Robertson of the National Science Foundation; Dr. William Shapley of the National Aeronautics and Space Administration; Dr. Chalmers W. Sherwin of the Department of Defense; Dr. Ernest E. Saulmon of the United States Disarmament Agency, and observers from other offices and agencies.

distribution of funds, and the steps taken by each agency to implement the policies set forth by the President. The agencies began to submit this information in October and November 1965, and have continued to do so.

On the basis of these reports and other data, CASE is attempting to put together a comprehensive picture of the over-all distribution of federal research funds to educational institutions.[1] Should CASE succeed in doing so, it will have accomplished something that no one else has been able to accomplish since federal agencies began to fund academic research on a large scale in the 1940's. The House Committee on Education and Labor observed in the Green Report in 1963 that "while the Federal Government is involved in many parts of the educational system, and a major partner in the higher education system, there is little evidence of a well-coordinated program."[2] The committee asserted that attempts at policy making and evaluation in the area of

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[1]The first report of CASE's efforts was released in August, 1966. See National Science Foundation, Federal Support for Academic Science and Other Educational Activities in Universities and Colleges Fiscal Year 1965, A Report Prepared by the National Science Foundation for the Office of Science and Technology (Washington: National Science Foundation, 1966). The basic information in this report is summarized in Chapter II below.

[2]U.S. Congress, House, Committee on Education and Labor, The Federal Government and Education, Report of the Special Subcommittee on Education, 88th Cong., 1st Sess., 1963, p. iii.

federal relationships to universities and colleges are hampered by "the inadequacy and misleading nature of available educational statistics."[1]

It is generally recognized that improvement in existing data collection and analysis is a condition precedent to the formulation of anything resembling a coherent federal policy for the funding of academic research.[2] Insofar as the President's Memoranda have provided an incentive to the major academic research funding agencies to cooperate in the improvement of existing data collection and analysis procedures, the President's Memoranda already have had an impact of potentially great significance.

The long range significance of the President's Memoranda, however, will undoubtedly lie in the effect that the Memoranda may have on several important issues that have developed in the funding of academic research by federal agencies since the late 1940's.

The Issues to Which the Memoranda are Directed

The Memoranda are explicitly directed to two issues: (1) the geographical and institutional distribution of

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[1] Ibid.

[2] See, for example, Werner Z. Hirsch, "Education in the Program Budget," Program Budgeting, ed. David Novicks (Cambridge: Harvard University Press, 1965), pp. 178-207.

federal research funds, an issue that can be defined in many ways, depending on the criteria used to measure fund distribution, and (2) the terms and conditions under which funds should be provided to universities and colleges for research purposes. In addition, the President's Memoranda implicitly recognize two other issues that have materialized in the 1960's, the issue of responsibility in the administration of federal academic research funds, and the issue of the extent to which academic research should be oriented to the satisfaction of civilian as distinguished from military purposes.

As Don K. Price[1] and others[2] have observed, the persistence of these related issues from 1945 to 1965 is symptomatic of instabilities and ambiguities in the federal academic research funding system and the totality of federal policies and actions towards the support of higher education as such. The issues to which the President's Memoranda are directed are not new. The issue of geographical distribution of research funds and the issue of the terms of support were both debated in the course of the hearings on the establishment

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[1] Don K. Price, "Federal Money and University Research," Science, CLI, No. 3708 (January 21, 1966), 285.

[2] Boyd R. Keenan (ed.), Science and the University (New York: Columbia University Press, 1966). See, also, National Academy of Sciences, Science, Government, and the Universities (Seattle: University of Washington Press, 1966).

of the National Science Foundation in the 1940's.[1] The issues were resolved in favor of those who supported the distribution of funds primarily on the basis of the merit of the proposed research to individual faculty members, although the act creating the Foundation does contain a provision that the Foundation shall "avoid undue concentration of such research and education."[2]

As the magnitude of federal spending for academic research increased throughout the 1950's and early 1960's and the impact of federal research funds on universities and colleges came under intense scrutiny,[3] these issues were again raised in many quarters, particularly in several congressional committees.[4]

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[1]See the statement of Edmund Day, President of Cornell University, in U.S. Congress, Senate, Committee on Military Affairs, Science Legislation, Hearings, 79th Cong., 1st Sess., 1945, p. 794. See also, Clarence A. Mills, "Distribution of American Research Funds," Science, CVII (February 6, 1948), 127.

[2]National Science Foundation Act of May 10, 1950, 64 Stat. 149, 42 U.S.C.A., secs. 1861-1875, as amended.

[3]See Harold Orlans, The Effects of Federal Programs on Higher Education (Washington: The Brookings Institution, 1962); U.S. Congress, House, Select Committee on Government Research, Impact of Federal Research and Development Programs, Report, 89th Cong., 2d Sess., 1964.

[4]U.S. Congress, House, Committee on Science and Astronautics, Government and Science 1964; Distribution of Federal Research Funds and Indirect Costs re Federal Grants, Hearings before the Subcommittee on Science, Research and Development, 88th Cong., 2d Sess., 1964 (hereafter referred to as House, Committee on Science and Astronautics, Distribution of Federal Research Funds . . .); U.S. Congress, House, Committee on Government Operations, Conflicts Between the Federal Research Programs and the Nation's Goals for Higher Education, Hearings and Report of the Research and Technical Programs Subcommittee, 89th Cong., 1st Sess., 1965 (hereafter referred to as House, Committee on Government Operations, Conflicts Between the Federal Research Programs . . .).

By late 1965, the pressures for some changes in the academic research funding system had attained the form of legislative proposals.[1] In early 1966, Representative George P. Miller of California, Chairman of the House Committee on Science and Astronautics, introduced H.R. 13786, which proposes the distribution of $150 million in research funds annually by the National Service Foundation to universities and colleges on a formula basis. The bill was drafted with the direct assistance of officers of the Association of State Universities and Land Grant Colleges.[2] By the terms of the bill, one-third of the $150 million would be distributed to institutions according to the number of advanced degrees in science awarded by an institution, one-third would be distributed to institutions within each state on the basis of the national percentage of high school graduates in the state in a given year, and one-third would be distributed to institutions in amounts proportional to sums already

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[1] See, e.g., John Walsh, "Demand for Institutional Support Attains the Form of Legislation," Science, CLII, No. 3725 (May 20, 1966), 1041.

[2] See "A Proposal for a New Program of Institutional Support in the Sciences," issued by the Executive Office of the Association of State Universities and Land-Grant Colleges, Washington, D.C., 1966. See, also, the statement of Dr. Elmer Ellis, President of the University of Missouri, on behalf of the Association of State Universities and Land-Grant Colleges, in House Committee on Science and Astronautics, Government and Science, 1964; Distribution of Federal Research Funds . . . , pp. 551-69.

being received from federal agencies. The Miller Bill is an attempt to handle the distribution problem on a formula basis similar in some respects to the formula method used to finance agricultural research.[1]

In a related development, in early March 1966, Senator Carl T. Curtis of Nebraska introduced in the Senate Resolution No. 231 which would direct the National Science Foundation to suggest changes in existing law

> . . . to provide for a more equitable distribution of [research and development] funds to all qualified institutions of higher learning to avoid the concentration of such activities in any geographical area and to insure a reservoir of scientific and teaching skills and capacities throughout the several states.[2]

Neither the Miller Bill nor the Curtis Resolution was passed by the House or Senate in 1966, but in July and August 1966, the Subcommittee on Government Research of the Senate Committee on Government Operations held hearings on the Curtis Resolution.[3]

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[1]The similarities are explored by Christian K. Arnold, the Associate Executive Secretary of the Association of State Universities and Land-Grant Colleges, who is credited with drafting the Miller Bill, in "Higher Education--Fourth Branch of Government?" Saturday Review, XLVII (January 18, 1964), 60.

[2]See Daniel S. Greenberg, "Science Policy: When Congress Looks for a Leader NSF is Usually Nominated," Science, CLII, No. 3719 (April 8, 1966), 184.

[3]These hearings have not been published at the time of this writing. These hearings are discussed in Chapter V below.

The point of importance is that the demands expressed in the President's Memoranda are not isolated ones, but grew out of widespread dissatisfaction with certain aspects of the policies and procedures used by federal agencies to fund academic research. The implications of the President's Memoranda must be assessed in the context of an analysis of the source and nature of the demands made on the academic research funding system in the 1960's. In order to make such an assessment it is necessary to examine the structure of the federal academic research system, the impact of this system on the financing of higher educational institutions in the United States, and the basic policies and procedures for funding academic research that have been followed in this system.

The demands for changes in the system are meaningful only in the context of an analysis of how the federal academic research system thus far has functioned.

CHAPTER II

THE FEDERAL ACADEMIC RESEARCH FUNDING SYSTEM AND ITS IMPACT ON THE FINANCIAL STRUCTURE OF HIGHER EDUCATION IN THE UNITED STATES

The Federal Academic Research Funding System

In analyzing the implications of the President's Memoranda it is useful to think of the group of executive offices and agencies involved in the funding of academic research as one subsystem of the federal governmental system. The term "system" is used in this context in the common, dictionary sense to refer to an assemblage of units related by some form of interdependence.[1] The term is not used in this context in the technical sense in which it is used by some political analysts.[2]

There are several reasons for thinking of the executive offices and agencies involved in the funding of academic research as a system. The first is that the many separate actions of the various units in the system have a cumulative impact on universities and colleges in

[1] See Webster's New Collegiate Dictionary, 1961 ed.

[2] See, e.g., David Easton, A Framework for Political Analysis (Englewood Cliffs, N.J.: Prentice-Hall, 1965), and David Easton, A Systems Analysis of Political Life (New York: John Wiley and Sons, 1965). See, also, William C. Mitchell, The American Polity (New York: The Free Press of Glencoe, 1962).

the United States. As Charles Kidd has emphasized, the federal government as a whole has only vague academic research policies and objectives. "Federal policy" is simply the sum of the policies of the various agencies.

> But so far as universities are concerned, the total effect of research funds provided by all federal agencies cannot be adequately assessed by looking separately at the effects of each segment.[1]

The total effect can be assessed only by looking at the sum of effects of the actions of all of the agencies on universities and colleges, insofar as this can be determined from the evidence available.

The second reason is that the President's Memoranda are addressed to all of the research funding agencies, and call for a response from all of the agencies. In terms of the demands made upon it, such as to strengthen the system of higher education in the United States, the group of offices and agencies must be analyzed as a whole. Although the system is a highly decentralized one, what one unit in the system does often affects what other units do. The President's Memoranda pose the perennial question of meaningfully relating the actions of all of the agencies to each

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[1] Charles V. Kidd, American Universities and Federal Research (Cambridge: Harvard University Press, 1959), p. 5.

other to achieve a given objective. Conceptualizing the agencies and executive offices as a system helps to direct attention to some of the problems of doing this.

Finally, the policies and procedures of the major agencies have certain common characteristics. In terms of the political effects of these policies and procedures, their common characteristics are more important than their individual differences.

The Units of the Federal Academic Research Funding System

The federal academic research funding system consists of two types of units, executive offices and operating agencies. There are five executive offices: the Office of the President's Special Assistant for Science and Technology; the President's Science Advisory Committee; the Federal Council for Science and Technology; the Office of Science and Technology, and the Bureau of the Budget. Measured by the size of expenditures on academic research, the major operating agencies are: the Department of Health, Education, and Welfare, particularly the National Institutes of Health; the Department of Defense; the National Science Foundation; the

Atomic Energy Commission, and the National Aeronautics and Space Administration. The role of each of these in the federal academic research funding system will be briefly described.

The Office of the President's Special Assistant for Science and Technology was created by President Eisenhower in 1957. The Special Assistant is appointed directly by the President and is not answerable to Congress. His primary duty is to advise the President on a confidential basis on scientific affairs.[1] His influence stems from his direct access to the President, and his position as Chairman of the President's Science Advisory Committee, Director of the Office of Science and Technology, and Chairman of the Federal Council on Science and Technology.[2] His role in formulating policy for the federal academic research funding system is closely related to his role as Director of the Office of Science and Technology.

The Office of Science and Technology was established

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[1]For a discussion of how this position was viewed by one Science Advisor, see Jerome B. Wiesner, "The Role of Science in Universities, Government, and Industry: Science and Public Policy," The Scientific Endeavor, ed. National Academy of Sciences (New York: The Rockefeller Institute Press), pp. 279-92.

[2]For an analysis of factors affecting the influence of the President's Science Advisor, see Philip H. Abelson, "The President's Science Advisors," Minerva, III (Winter, 1965), 149-58.

in the Executive Office in 1962[1] as a result of expressions of congressional dissatisfaction with previous Executive Office efforts to develop a meaningful national research policy.[2] Reorganization Plan No. 2 of 1962 transferred to the Office of Science and Technology most of the authority originally vested in the National Science Foundation, by its organic Act,[3] to develop and encourage the pursuit of a national policy for the promotion of basic research and education in the sciences and to evaluate scientific research programs undertaken by agencies of the federal government. According to the Director of the Foundation, the Foundation has retained some of the policy functions assigned by Reorganization Plan No. 2 to the Office of Science and Technology, particularly those aspects of policy making related to information gathering and analysis.[4] The

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[1] Reorganization Plan No. 2 of 1962, 76 Stat. 1253.

[2] U.S. Congress, Senate, Committee on Government Operations, Organizing for National Security, Science Organization, and the President's Office, Report of the Subcommittee on National Policy Machinery, 86th Cong., 1st Sess., 1962.

[3] National Science Foundation Act of May 10, 1950, 64 Stat. 149, 42 U.S.C.A., secs. 1861-1875, as amended.

[4] Statement of Leland J. Haworth, Director, National Science Foundation, in U.S. Congress, House, Committee on Science and Astronautics, Government and Science, 1965: Review of the National Science Foundation, Hearings before the Subcommittee on Science, Research, and Development, 89th Cong., 1st Sess., 1965, Vol. I, p. 15 (hereafter referred to as House Committee on Science and Astronautics, Review of the National Science Foundation . . .).

President's Memoranda originated in the Office of Science and Technology, and constitute an effort by the Office to meaningfully exercise its policy functions in relation to academic research.[1]

In his testimony before the House Independent Offices Appropriations Subcommittee in February 1966, Donald Hornig asserted that the Office of Science and Technology is attempting to provide leadership in the whole area of federal funding of academic research.

> It is not just a matter of coordination. It is a matter of exerting some leadership. For example, the President issued a policy statement this fall on strengthening academic science. The initiative on this came largely from our organization, although we worked with the heads of departments and agencies. . . . The implementing of that policy cannot be a piecemeal thing. So our staff has been working with all the agencies now to implement the President's policy with regard to higher education.[2]

It remains to be seen whether the Office will wield enough influence to become the leader in the formulation of federal academic research policy. This in turn will depend in good part on the degree of support the Office receives from the President in its dealings with the operating agencies.

[1] Statement of Donald F. Hornig, Director of the Office of Science and Technology, in U.S. Congress, House, Committee on Appropriations, Independent Offices Appropriations for 1967, Hearings, 89th Cong., 2d Sess., 1966, pp. 13-18.

[2] Ibid., p. 21.

The President's Science Advisory Committee was created by President Eisenhower in December 1957, out of the old Science Advisory Committee of the Office of Defense Mobilization. It is composed of the President's Special Assistant for Science and Technology, and prominent scientists appointed directly by the President for four-year terms. The committee advises the President on scientific affairs, and conducts studies both at the President's request and under its own initiative. In conducting its studies, the committee relies on about 300 consultants from the scientific community for advice. The committee is fundamentally an advisory body. As described by the President's Science Advisor, the basic function of the committee is

> . . . to make directly available to the President the considered views of 17 eminently qualified scientists and engineers from outside the Government, and through the committee and its panels, to make available to the President the views of experts from anywhere in the United States on special topics as they arise.[1]

In the 1960's, the President's Science Advisory Committee (PSAC) has issued two reports of direct importance to the funding of academic research by federal

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[1] Statement of Donald F. Hornig, in House, Committee on Science and Astronautics, Review of the National Science Foundation . . . , Vol. I, p. 103.

agencies, Scientific Progress, the Universities, and the Federal Government,[1] and Meeting Manpower Needs in Science and Technology,[2] issued in 1962. Both of these reports emphasize the proposition that federal research programs should be designed to strengthen capacities of American universities to perform research and produce scientific manpower.

The Federal Council for Science and Technology was created by President Eisenhower on March 13, 1959.[3] The Council is composed of one policy-making representative from each of the major research funding agencies. Its basic functions are to promote cooperation among the agencies in formulating research policies, and to provide a regular means of communication among executive office officials and policy-making officials in the agencies. The Council carries on many of its coordinating functions through a number of interagency committees on such subjects as Atmospheric Sciences, Behavioral Science, High Energy Physics, Long Range Planning, and Materials Research and Development. As noted in Chapter I, the

[1] President's Science Advisory Committee, Scientific Progress, the Universities, and the Federal Government (Washington: U.S. Government Printing Office, 1960).

[2] Ibid., Meeting Manpower Needs in Science and Technology (Washington: U.S. Government Printing Office, 1962).

[3] Executive Order 10807, March 13, 1959.

Council through its interagency Committee on Academic Science and Engineering is attempting to work out among the agencies a coherent response to the President's Memoranda.

The Bureau of the Budget is the fifth unit in the executive superstructure for research and development. Under a reorganization plan that became effective in 1965, the Education, Manpower, and Science Division of the Bureau is responsible for the analysis of academic research programs. The bureau attempts to evaluate academic research programs, as it evaluates other programs, in terms of their consistency with each other and with over-all federal budgetary objectives. The method used by the bureau in contributing to the formulation of science policy has been described by William D. Carey, an assistant director of the bureau, as follows:

> The Bureau of the Budget has never agreed with suggestions that it should establish within its structure a Division of Science, staffed with qualified scientists and engineers, to review R and D proposals. We prefer to do our work [illegible], and by using a broad approach which examines program issues in the field of science and technology from the standpoints of public policy, soundness of justification, and the availability

Gove[illegible]
Pro[illegible]

> of money and manpower, and the balance of financial effort as among alternative program commitments.[1]

The bureau not only participates in the formulation of executive proposals to Congress on the research and development budgets of the various agencies, but also issues recommendations and regulations on the administration of research contracts and grants, that affect the practices followed by all of the research funding agencies.[2]

The presidential superstructure for research policy has been criticized on the grounds that it is an unwieldy structure in which responsibilities are unclear, that it is not representative of the "scientific community" or the "educational community," that it concentrates too much power in the President's Science Advisor, and that it has not been effectively used to examine problems of a fundamental nature that have important long-term implications for the development of

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[1] See William D. Carey, "Research, Development, and the Federal Budget," address before the Seventeenth National Conference on the Administration of Research, September 11, 1963. See, also, William D. Carey, "Needed: An Annual Report to Congress on Science and Technology," Air Force and Space Digest, XLIX (February, 1966), 51.

[2] E.g., Bureau of the Budget, The Administration of Government Supported Research at Universities (Washington: Executive Office of the President, 1966).

American science.[1]

Whatever the merits of these and similar criticisms, the President's Memoranda represent an attempt to increase the authority of the President's Science Advisor and the Office of Science and Technology in the formulation of federal policies affecting academic research. This in turn raises several problems about the relationships of the Office of Science and Technology on the one hand, to the agencies on the other.

The lack of any uniform federal academic research policy is largely explained by the fact that for all of the academic research funding agencies except the National Science Foundation (NSF), and to an indeterminate degree the National Institutes of Health, the support of academic research is not an end in itself, but a means to other ends determined by Congress and the agencies' interpretations of their missions. The major mission-oriented agencies, the Department of Defense, the Atomic Energy Commission, the National Aeronautics and Space Administration, and to some extent the National Institutes of Health, have

[1] See, for example, Abelson, Minerva, III, 149-58; Alvin M. Weinberg, "Criteria for Scientific Choice," Minerva, I (Winter, 1963), 159-71; Ralph E. Lapp, The New Priesthood (New York: Harper and Row, 1965). For a favorable view, see "White House Superstructure for Science," Chemical and Engineering News, XLII (October 9, 1964), 79-92.

consistently maintained that they support academic research to secure information relevant to the performance of their missions, and only secondarily to develop the institutions at which the research is performed, or to achieve some other objective.[1]

To varying degrees, the mission-oriented agencies have attempted to accommodate demands for geographical distribution of funds and for grants to institutions themselves,[2] but the critical fact is that the mission agencies feel compelled to subordinate these demands to performance of the missions imposed upon them by Congress.

In other terms, for these agencies academic research policy is only one aspect of national defense policy, or national space policy, or national health policy.

The major exception to this rule is the National Science Foundation. The Act establishing the Foundation provided inter alia:

> Sec. 3 (a) The Foundation is authorized and directed
> (1) to develop and encourage the pursuit of

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[1] The positions of the major agencies on this question were expressed by the agencies to the Daddario Subcommittee in the course of its hearings on the National Science Foundation in 1965. See House Committee on Science and Astronautics, Review of the National Science Foundation . . . , passim.

[2] See Chapter III below.

> a national policy for the promotion of basic research and education in the science . . . (6) to evaluate scientific research programs undertaken by agencies of the Federal Government . . .

Reorganization Plan No. 2 of 1962 created the Office of Science and Technology and transferred to it:

> So much of the functions conferred upon the Foundation by the provisions of section 3 (a)(1) of the National Science Foundation Act of 1950 . . . as will enable the Director to advise and assist the President in achieving coordinated Federal policies for the promotion of basic research and education in the sciences [and] the functions conferred upon the Foundation by that part of . . . the National Science Foundation Act of 1950 . . . which reads as follows: "to evaluate scientific research programs undertaken by agencies of the Federal Government."

Because of its relative weakness in relation to other research funding agencies throughout the 1950's, the Foundation was unable to effectively discharge these functions.[1]

As noted above, according to the Director of the Foundation, the Foundation has retained certain aspects of the policy function assigned by Reorganization Plan No. 2 to the Office of Science and Technology.

> Certain aspects of it are still, in a sense, our prime responsibility--the information gathering, for example, the Manpower Register,

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[1] See U.S. Congress, House, Committee on Science and Astronautics, The National Science Foundation, A General Review of Its First 15 Years, Report of the Science Policy Research Division, Legislature Reference Service, Library of Congress, to the Subcommittee on Science, Research, and Development, 89th Cong., 1st Sess., 1965, pp. 3-9 (hereafter referred to as House Committee on Science and Astronautics, The National Science Foundation, A General Review of Its First 15 Years . . .). See also, Dael Wolfle, "National Science Foundation, the First Six Years," Science, XXVI, No. 3269 (August 23, 1957), 335; Alan T. Waterman, "National Science Foundation, A Ten-Year Resumé," Science, CXXXI, No. 3410 (May 6, 1960), 1341.

> and various things of that sort. . . . Let us say the primary initiative for the development of policy is . . . now in the Office of Science and Technology.[1]

In March 1966, Representative Emilio Q. Daddario introduced H.R. 13696, a bill designed in part to strengthen the policy functions of the Foundation in relation to the general welfare of American science.[2] However, the Foundation has traditionally been a passive agency.[3] It is highly questionable whether the Foundation in the near future will be able to develop the political skill that would be necessary for it to assume a commanding position in the formulation and execution of a government-wide academic research policy.

Despite the efforts of the Office of Science and Technology, it is clear as of 1966 that no particular office or agency is in a position of sufficient political power to make and enforce a government-wide academic research policy. This situation in the 1960's has constituted a standing invitation to congressional committees to attempt to influence policy making through investigatory and authorization processes. While these attempts by

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[1] House Committee on Science and Astronautics, Review of the National Science Foundation, . . . Vol. I, p. 15.

[2] See Emilio Q. Daddario, "A Revised Charter for the Science Foundation," Science, CLII, No. 3718 (April 1, 1966), 42.

[3] See Chapter IV below.

congressional committees are analyzed in detail in Chapter IV below, the underlying reasons for the rise of congressional interest in the funding of academic research can be briefly summarized as follows.

With the exception of agricultural research, the federal academic research funding system was developed in the 1940's and 1950's to produce information of immediate or potential value to the major mission-oriented agencies in the performances of their missions on the one hand, and to produce information relevant to the development of various scientific disciplines through the National Science Foundation and to some extent National Institutes of Health programs on the other. The basic rationale underlying the funding of academic research by the Department of Defense, the Atomic Energy Commission, the National Institutes of Health, and the National Aeronautics and Space Administration has been the development of information judged to be important to national defense, atomic energy development, public health, and space exploration. The basic rationale underlying the support of academic research by the National Science Foundation and to

some extent the National Institutes of Health has been the production of information to develop the physical and biological sciences for the social value that the information produced might have in the future.

The system has been at least in theory essentially a merit system. The basic criteria used in the allocation of funds have been the merit of the proposed research and the record of the proposant. The basic legal and administrative devices used to fund academic research have been based on a mixture of contract and grant principles. Under these principles, great weight has been given to the judgment of scientists of established reputation in the determination of who should receive research funds. The whole system has been predicated on the basic proposition that it is in the national interest to allocate public funds to private performers--individual scientists in universities--because the information produced by these individual performers is of potential or immediate value to the realization of specified national objectives.

In the late 1950's and in the 1960's several important

changes have materialized in the environment of the system. These changes have been translated into political demands for substantial modifications in the system, particularly in the direction of the support of research as a means to the realization of educational, economic, and social welfare ends. The first is the continuing rise of financial pressures on universities and colleges posed by increasing enrollments and increased competition, coupled with the magnitude of the involvement of the federal government in the financing of institutions of higher education through research programs.[1] These changes have gradually extended the arena of competition of universities and colleges for funds from private and state legislative sources to federal agencies and Congress.

The second change in the environment of the system has been the continuing shift in the economy from an industrial-production orientation towards a knowledge-service orientation, with attendant demands for trained,

[1]See Economics of Higher Education, ed. Selma J. Mushkin, U.S. Department of Health, Education, and Welfare, Office of Education (Washington: U.S. Government Printing Office, 1962); U.S. Department of Health, Education, and Welfare, Office of Education, Projections of Educational Statistics to 1974-75 (Washington: U.S. Government Printing Office, 1965); National Science Foundation, Comparisons of Earned Degrees Awarded 1901-1962, with Projections to 2000 (Washington: National Science Foundation, 1964).

technically skilled personnel in such areas as health, education, communications, and insurance.[1] Since health, education, and other knowledge-dependent industries in part depend on and are stimulated by the geographical proximity of research-oriented universities and institutions, this shift has contributed to and provided a rationale for "pork barrel" demands for the distribution of research funds in part on the basis of geographical need.

The third change in the environment of the system is the continuing urbanization[2] of the United States and an increase of awareness in some of the problems posed by this development, such as massive pollution of the atmosphere. The phenomenon of continuing urbanization has generated demands that a more substantial part of the research brainpower of the country be directed to urban and environmental problems.

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[1]For analyses of these trends, see the annual editions of the Economic Report of the President and the Annual Report of the Council of Economic Advisers. For a thorough analysis of the relevance of research to these trends, see Economic Report of the President, Together with the Annual Report of the Council of Economic Advisers, 1964 (Washington: U.S. Government Printing Office, 1964), "The Promise and Problems of Technological Change," Chap. 3, pp. 85-111.

[2]For an analysis of this trend, see John C. Bollens and Henry J. Schmandt, The Metropolis (New York: Harper and Row, 1965). For various analyses of the potential relevance of research to urban problems, see U.S. Department of Housing and Urban Development, "Summary Reports and Recommendations of a Summer Study on Science and Urban Development," unpublished papers of a conference held June 5 to June 25, 1966.

Throughout the 1950's Congress with a few exceptions played a relatively modest role in the examination and criticism of federal academic research policies. However, the research funding system has not changed in relation to its social and political environment. Policies and procedures established in the 1940's and 1950's have been carried over into the 1960's with only slight modifications. The basic role of Congress in the 1960's has been to translate major changes in the environment of the system into political demands for changes in the system.

In order to analyze the nature of the demands that various congressional committees have expressed on the system, it is first necessary to examine in greater detail the magnitude of the involvement of the system with the financing of institutions of higher education in the United States, and the policies and procedures thus far pursued in the system.

The Impact of the Federal Academic Research Funding System on the Financing of Higher Education in the United States

Harvey Brooks has observed that in any attempt to get a meaningful view of federal research and development activities

it is necessary to use budgetary statistics because these are the only common measure of such diverse activities.[1] This section examines federal academic research funds as a component of the income of universities and colleges in the United States, the pattern of university and college expenditures for research purposes, the source of funds by agency, and the institutional and geographical distribution of funds. The emphasis in this analysis is on the period 1955 to 1965, since this is the period for which some data are available.

At the outset it must be stressed that there are very substantial problems in the collection and analysis of research and development statistics in general, and academic research statistics in particular.[2]

The following are some of the most important problems involved in the use of these statistics. (1) The definitions used by various organizations engaged in the performance of research and development, in sponsoring research and development, and in analyzing research and development have varied over the years, and to some extent still vary today. (2) No

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[1] National Academy of Science, National Research Council, Effects of Current Trends on the Support of Research (Washington: National Academy of Science, 1965).

[2] See National Science Foundation, Methodology of Statistics on Research and Development (Washington: U.S. Government Printing Office, 1959). See also, National Academy of Science, Basic Research and National Goals (Washington: National Academy of Science, 1965), Appendix A.

single organization has systematically attempted to collect and to analyze comprehensive data on research support received by universities and research conducted in universities over the years, although the National Science Foundation and the Office of Education have made important efforts in this direction, especially since 1955. (3) Some organizations use accounting periods based on the calendar year, while others use a fiscal year. This makes it difficult to classify the activities of all organizations by year. (4) There is a difference between obligations, which represent the amounts of orders placed, contracts awarded, and similar transactions, and expenditures, which represent the amount of money paid out in a given period, irrespective of when the obligations were incurred. Information on one of these is sometimes available, while information on the other is not. (5) Figures on certain performances of agencies and universities simply have never been compiled in a manner that is desirable for analytical purposes. For example, most analysts agree that for many purposes it is desirable to separate figures on research from figures on development, because these two activities are

different in character. Ideally, it would also be possible to distinguish between figures on basic research and figures on applied research. Unfortunately, it is not always possible to separate the figures for these different kinds of activities, particularly when analyzing federal funds for academic research as a component of the income of universities and colleges. For these and similar reasons the figures in this section should be regarded as gross indicators of certain kinds of relationships rather than as exact descriptions of these relationships in statistical form.

Federal Academic Research Funds as a Component of the Income of Institutions of Higher Education in the United States

The two sources of data on federal research funds as a component of the income of universities and colleges are the National Science Foundation and the Office of Education. The National Science Foundation has produced three thorough statistical analyses of government-university research relationships: Scientific Research and Development in Colleges and Universities--Expenditures and Manpower, 1953-54, 1959; Scientific Research and Development in Colleges and

Universities--Expenditures and Manpower, 1958, 1962; and Scientists and Engineers in Colleges and Universities, 1961, 1965.[1] An analysis for 1964-65 is scheduled for publication in 1967.[2] Unfortunately, the National Science Foundation only reports data for every fourth year, and the data in NSF reports are not comparable to the data on university and college income collected by the Office of Education because of differences in the reporting systems used.

The Office of Education collects and reports information on income from the approximately 2,207 institutions of higher education in the United States every other year.[3] In the Office of Education's reporting system the classification of federal funds received by an institution as funds for research is made by the officials of the institution

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[1] Each of these studies was published by the Government Printing Office, Washington.

[2] For a preliminary report of this analysis see National Science Foundation, "Resources for Scientific Activities at Universities and Colleges, 1964," Reviews of Data on Science Resources, No. 9, August, 1966.

[3] This was the number for 1965-66. The number varies slightly from year to year. See, U.S. Office of Education, Education Directory 1965-1966, Part 3, Higher Education (Washington: U.S. Government Printing Office, 1966).

who fill in the reporting form.[1] This is also true of the surveys conducted every four years by the National Science Foundation. This raises the nearly insolvable problem of what funds received from federal agencies should and should not be classified as funds for research.

The surveys of both the National Science Foundation and the Office of Education depend on consistency by university reporting officers in applying the criteria specified in the survey forms for the inclusion of income from federal agencies as income for research. The forms used by the National Science Foundation follow the Foundation's standard practice of classifying funds by basic research, applied research, and development.[2] In addition, the Foundation's reporting system distinguishes between funds for research performed in universities and colleges proper, and funds for research performed in university-associated contract research centers. These distinctions were not made in the Office of Education reporting system up to 1966, although the Office is currently in the process of

[1] For an example of the type of form used in the 1950's and 1960's, see U.S. Office of Education, Financial Statistics of Institutions of Higher Education, 1956-60 (Washington: U.S. Government Printing Office, 1964), pp. 179-91.

[2] See National Science Foundation, Methodology of Statistics on Research and Development (Washington: U.S. Government Printing Office, 1959).

revising its reporting system. As a result, the Office of Education figures are gross figures. Nonetheless, in attempting to determine the percentage of university and college income over time composed of federal research funds, these data are the most comprehensive available.

The Office of Education uses six classifications in reporting the incomes of institutions of higher education: (1) current funds, (2) endowment and other non-expendable funds, (3) loan funds, (4) annuity and living trust funds, (5) plant funds, and (6) agency funds.[1]

Federal funds for research and development are classified under current funds. There are three kinds of current funds: (1) educational and general funds, (2) auxiliary enterprises funds, and (3) student-aid funds. Educational and general funds include funds available for the regular instructional and research programs of the institutions, such as salaries and expenses of faculty and other employees, purchase of supplies for current use in classrooms, libraries, laboratories and offices, and operation and maintenance of the educational plant. Federal

[1]See U.S. Office of Education, Financial Statistics of Institutions of Higher Education, 1959-60, p. 10.

research and development funds are classified as educational and general funds.

The identifiable federal contribution to current income of institutions of higher education[1] in this century has taken four primary forms: (1) funds for land-grant institutions; (2) funds for the training of federal personnel, payments for maintaining records on students under specified laws, and other purposes; (3) funds for veterans' tuitions and fees, paid directly to universities and colleges, as distinguished from funds paid directly to veterans for educational purposes; and (4) funds for research and development carried on at universities and colleges and related contract research centers. As is indicated in Table 1, federal funds as a component of the current income of institutions of higher education have varied in the last fifty years from a low of 3.7 percent in 1929-30, to a high of an estimated 22.4 percent in 1963-64.

In 1950, all federal funds constituted 22.1 percent of total university and college current income. This was the highest percentage of current income composed of federal

[1]For the statement of the criteria for classification as an institution of higher education, see U.S. Office of Education, Education Directory 1965-1966, Part 3, Higher Education.

TABLE 1

FEDERAL FUNDS AS A COMPONENT OF CURRENT INCOME[a] OF INSTITUTIONS OF HIGHER EDUCATION, SELECTED YEARS, 1909-1910 TO 1963-1964
(in thousands of dollars)

Year	Current Income	Identifiable Federal Funds	Identifiable Federal Funds as a Percentage of Current Income
1909-10	$ 82,007	$ 4,813	5.9
1919-20	200,136	12,783	6.4
1929-30	556,845	20,658	3.7
1939-40	720,095	39,537	5.5
1949-50	2,390,079	527,033	22.1
1951-52	2,579,364	453,412	17.6
1953-54	2,966,264	419,543	14.1
1955-56	3,628,773	493,886	13.6
1957-58	4,675,513	712,431	15.2
1959-60	5,812,759	1,040,899	17.9
1961-62	7,466,461	1,542,056	20.7
1963-64[b]	9,569,900	2,142,200	22.4

Basic sources: U.S. Office of Education, Digest of Educational Statistics, 1964 edition, Table 80, p. 98, and 1965 edition, Tables 76 and 78, pp. 97 and 100.

[a]Current income is composed of: educational and general income, auxiliary enterprise income, and student-aid income. From 1909-1910 to 1963-1964, educational and general income comprised approximately 80 percent of current income, auxiliary income about 18 percent, and student-aid income about 2 percent.

[b]Estimated.

funds, up to that time. As veterans' tuitions and fees declined in the period 1949-50 to 1959-60, there was a decline in the percentage of current income composed of federal funds, from 22.1 percent to 17.9 percent. However, as indicated in Tables 2 and 3, the decline in funds for veterans' tuitions and fees was largely, although not entirely, offset by increases in research funds. Increases in federal research funds continued in the 1960's, with the result that in 1963-64 federal funds constituted 22.4 percent of university and college income, the highest percentage in history. This 22.4 percent was composed largely of funds for research and related purposes. As is indicated in Table 3, the percentage of current income received from the federal government in 1963-64, 22.4 percent, slightly exceeded the percentage of income received from state governments, 22.3 percent, traditionally the source of the highest percentage of the annual income of universities and colleges in the United States.

As is indicated in Tables 4 and 5, in 1951-52 federal research funds constituted about 49 percent of the

TABLE 2

CURRENT INCOME OF INSTITUTIONS OF HIGHER EDUCATION, BY SOURCE AND AMOUNT, SELECTED YEARS, 1909-1910 TO 1963-1964
(in thousands of dollars)

Source	Year							
	1909-10	1919-20	1924-30	1939-40	1949-50	1959-60	1961-62	1963-64
Total	$82,007	$200,136	$556,845	$720,095	$2,390,079	$5,812,759	$7,466,461	$9,569,900
Student tuition and fees[a]	19,426	42,263	144,624	201,831	395,855	1,161,753	1,505,329	1,880,700
Federal Government	4,813	12,783	20,658	39,537	527,033	1,040,899	1,542,056	2,142,200
Identifiable funds								
Veterans' tuition and fees[a]	0	0	0	0	308,432	3,483	NR	NR
Land grant institutions[b]	2,998	4,709	16,389	31,889	48,245	88,297	103,135	118,135
Research[b]	c	c	c	c	c	828,734	1,274,364	1,776,400
Other purposes	1,815	8,074	4,269	7,648	170,356	120,384	164,557	247,565
State governments[d]	21,203	61,864	152,335	153,690	500,289	1,389,271	1,689,086	2,138,600
Local governments	e	e	e	24,392	61,378	151,715	191,188	229,000
Endowment earnings	12,681	26,485	68,620	71,364	96,370	206,666	232,341	264,900
Private gifts and grants	3,551	7,585	26,203	40,576	118,705	383,186	450,764	561,600
Related activities[f]	c	c	c	32,894	112,437	244,894	304,129	
Sales and services of educational departments	c	c	c	c	c	45,425	52,415	571,500[g]
Other educational and general	11,367	22,163	72,908	11,512	34,758	88,739	104,911	

TABLE 2--Continued

Source	Year							
	1909-10	1919-20	1924-30	1939-40	1949-50	1959-60	1961-62	1963-64
Auxiliary enterprises	$ 8,966	$ 26,993	$ 60,470	$144,299	$ 513,096	$1,005,963	$1,274,026	$1,629,400
Student-aid income[h]	c	c	c	c	16,288	94,248	120,216	152,100
Other current income	0	0	11,027	0	13,870	0	0	0

Source: U.S. Office of Education, Digest of Educational Statistics, 1965 edition, Table 78, p. 100.

NR = Not reported separately. Included in "other purposes."

[a]Tuition and fees received from veterans under Public Law 550, are reported under Student Fees and not under Income from the Federal Government.

[b]Income from the Federal Government for research at agricultural experiment stations administered by land-grant institutions is reported under land-grant institutions and not under Research.

[c]Data not separately collected.

[d]Includes federal aid received through State channels and regional compacts.

[e]Income tabulated under State.

[f]"Related activities" includes activities conducted primarily for the purpose of giving professional training to students, such as agricultural college creameries and medical-school hospitals.

[g]Breakdown not available.

[h]Funds received for fellowships, scholarships, prizes, and other forms of student aid not involving the rendering of service to the institution. The funds are specifically designated by the donors for student-aid purposes.

TABLE 3

PERCENTAGE OF CURRENT INCOME OF INSTITUTIONS OF HIGHER EDUCATION, BY SOURCE, SELECTED YEARS, 1909-1910 TO 1963-1964

Source	Year							
	1909-10	1919-20	1924-30	1939-40	1949-50	1959-60	1961-62	1963-64
Student tuition and fees[a]	23.7	21.1	26.0	28.0	16.6	20.0	20.2	19.7
Federal Government	5.9	6.4	3.7	5.5	22.1	17.9	20.7	22.4
Identifiable funds								
Veterans' tuition and fees[a]	0	0	0	0	12.9	0.6	NR	NR
Land grant institutions[b]	3.7	2.4	2.9	4.4	2.0	1.5	1.4	1.2
Research[b]	c	c	c	c	c	14.3	17.1	18.6
Other purposes	2.2	4.0	0.8	1.1	7.1	2.1	2.2	2.6
State governments[d]	25.9	30.9	27.4	21.3	20.9	23.9	22.6	22.3
Local governments	e	e	e	3.4	2.6	2.6	2.6	2.4
Endowment earnings	15.5	13.2	12.3	9.9	4.0	3.6	3.1	2.8
Private gifts and grants	4.3	3.8	4.7	5.6	5.0	6.6	6.0	5.9
Related activities[f]	c	c	c	4.7	4.7	4.2	4.1	
Sales and services of educational departments	c	c	c	c	c	0.8	0.7	6.0[g]
Other educational and general	13.9	11.1	13.1	1.6	1.5	1.5	1.4	

TABLE 3--Continued

Source	Year							
	1909-10	1919-20	1924-30	1939-40	1949-50	1959-60	1961-62	1963-64
Auxiliary enterprises	10.9	13.5	10.9	20.0	21.5	17.3	17.1	17.0
Student-aid income[h]	c	c	c	c	0.7	1.6	1.6	1.6
Other current income	0	0	2.0	0	0.6	0	0	0

Source: U.S. Office of Education, Digest of Educational Statistics, 1965 edition, Table 78, p. 100.

NR = Not reported separately. Included in "other purposes."

[a]Tuition and fees received from veterans under Public Law 550, are reported under Student Fees and not under Income from the Federal Government.

[b]Income from the Federal Government for research at agricultural experiment stations administered by land-grant institutions is reported under land-grant institutions and not under Research.

[c]Data not separately collected.

[d]Includes federal aid received through State channels and regional compacts.

[e]Income tabulated under State.

[f]"Related activities" includes activities conducted primarily for the purpose of giving professional training to students, such as agricultural college creameries and medical-school hospitals.

[g]Breakdown not available.

[h]Funds received for fellowships, scholarships, prizes, and other forms of student aid not involving the rendering of service to the institution. The funds are specifically designated by the donors for student-aid purposes.

total identifiable federal contribution to the current income of universities and colleges, or about 9 percent of the total current income of universities and colleges. In 1963-64, federal research funds constituted an estimated 83 percent of the federal contribution to university and college income, or about 19 percent of all university and college current income.

Of the approximately 2,100 institutions of higher education in the United States in the period 1955-56 to 1961-62, the period for which Office of Education data are available, federal research funds were located predominately in the approximately 141 universities in the United States, and in the 20 technological schools. As indicated in Table 6, the number of institutions reporting receipt of some federal research funds rose from 241 institutions in 1955-56, to 417 institutions in 1961-62. However, as indicated in Table 7, around 130 universities received about 80 percent of the funds each year, while about 20 technological schools received from 15 to 19 percent. The other 1,800 institutions received around 2 percent of

TABLE 4

FEDERAL RESEARCH FUNDS[a] AS A PERCENTAGE OF ALL FEDERAL INCOME FUNDS TO INSTITUTIONS OF HIGHER EDUCATION, 1951-1952 TO 1963-1964
(in thousands of dollars)

Year	Identifiable Federal Income Funds	Federal Research Funds	Federal Research Funds as a Percentage of Identifiable Federal Funds
1951-52	$ 453,412	$ 221,105	48.8
1953-54	419,543	282,379	67.3
1955-56	493,886	355,576	72.0
1957-58	712,431	534,389	75.0
1959-60	1,040,899	828,734	79.6
1961-62	1,542,056	1,274,364	82.6
1963-64[b]	2,142,200	1,776,400	82.9

Basic source: U.S. Office of Education, Digest of Educational Statistics, 1964 edition, Table 80, p. 98, and 1965 edition, Table 76, p. 97.

[a]Includes funds for development, and funds earmarked for contract research centers. Excludes funds to land-grant institutions for research.

[b]Estimated.

TABLE 5

FEDERAL RESEARCH[a] FUNDS AS A PERCENTAGE OF CURRENT INCOME OF INSTITUTIONS OF HIGHER EDUCATION, 1951-1952 TO 1963-1964
(in thousands of dollars)

Year	Current Income	Federal Research Funds	Federal Research Funds as a Percentage of Current Income
1951-52	$2,579,364	$ 221,105	8.6
1953-54	2,966,264	282,379	9.5
1955-56	3,628,773	355,576	9.8
1957-58	4,675,513	534,389	11.4
1959-60	5,812,759	828,734	14.3
1961-62	7,466,461	1,274,364	17.1
1963-64[b]	9,569,900	1,776,400	18.6

Basic source: U.S. Office of Education, Digest of Educational Statistics, 1964 edition, Table 80, p. 98, and 1965 edition, Table 76, p. 97.

[a]Includes funds for development, and funds earmarked for contract research centers. Excludes funds to land-grant institutions for research.

[b]Estimated.

federal research funds. Of the approximately 2,100 institutions of higher education in this period, about 220 offered Ph.D. degree programs, and an additional 450 offered master's degree programs.[1] At the time of this writing the data for 1961-62 were the latest Office of Education data available. Although dated, the data for the period 1955-56 to 1961-62 are important because they indicate in a rough way the situation out of which the demands on the federal academic research funding system arose in the late 1950's and early 1960's.

Expenditures for Organized Research in Universities and Colleges

The data on expenditures for organized research are similar to the data on income for research. The term "organized research" refers to research that is separately budgeted at the institutions where it is carried on. Expenditures for organized research, analyzed as a percentage of the total expenditures of institutions of higher education, rose from about 4 percent in 1929-30 to about 27 percent in 1963-64. Research expenditures rose from about 4 percent of all expenditures of institutions of higher education in 1939-40, to

[1] The exact figures vary from year to year. For the exact figures for a given year, see U.S. Office of Education, Education Directory, Part 3, Higher Education, for the appropriate year.

TABLE 6

FEDERAL FUNDS FOR RESEARCH[a] BY TYPE, CONTROL AND NUMBER OF INSTITUTIONS OF HIGHER EDUCATION, SELECTED YEARS, 1955-1956 TO 1961-1962
(in thousands of dollars)

	Institutions Reporting Receipt of Federal Research Funds							
	1955-56		1957-58		1959-60		1961-62	
	Number	Amount	Number	Amount	Number	Amount	Number	Amount
All institutions	241	$355,576	291	$534,389	347	$828,734	417	$1,274,364
Public	115	149,926	129	232,775	159	363,513	176	547,972
Private	126	205,650	162	301,613	188	465,221	241	726,392
Universities	120	276,333	126	410,638	132	655,244	134	958,647
Public	73	145,952	75	226,711	76	350,212	78	524,091
Private	47	130,381	51	183,927	56	305,032	56	434,556
Liberal Arts Colleges	60	5,261	100	7,922	126	18,629	184	31,120
Public	11	974	21	1,384	28	3,850	40	8,279
Private	49	4,287	79	6,537	98	14,779	144	22,840
Teachers Colleges	20	137	15	747	36	1,904	41	3,033
Public	18	57	13	342	34	1,644	38	2,502
Private	2	80	2	406	2	260	3	531
Technological Schools	17	70,723	19	105,745	21	139,989	24	253,209
Public	5	1,731	7	1,669	9	4,438	9	4,490
Private	12	69,992	12	104,076	12	135,551	15	248,719
Other Professional Schools	22	2,915	23	8,849	24	12,207	26	27,485
Public	10	1,170	6	2,640	7	3,340	7	8,581
Private	0	0	17	6,209	17	8,867	19	18,904

TABLE 6--Continued

	Institutions Reporting Receipt of Federal Research Funds							
	1955-56		1957-58		1959-60		1961-62	
	Number	Amount	Number	Amount	Number	Amount	Number	Amount
Junior Colleges	2	$206	2	$459	7	$754	8	$871
Public	1	41	1	1	4	23	4	29
Private	1	165	1	458	3	732	4	842
Technical Institutes and Some Professional Schools	0	0	6	30	1	7	0	0
Public	0	0	6	30	1	7	0	0
Private	0	0	0	0	0	0	0	0

Basic source: U.S. Office of Education, Statistics of Higher Education, 1955-56 edition, Table 3, p. 10; 1957-58 edition, Table 10, p. 22; 1959-60 edition, Table 11, p. 29; 1961-62 edition, unpublished Office of Education tables.

[a]Includes research and development at institutions proper and related contract centers. Excludes funds for research at land-grant institutions.

TABLE 7

FEDERAL FUNDS FOR RESEARCH,[a] BY PERCENTAGE ALLOCATED TO TYPES OF INSTITUTIONS OF HIGHER EDUCATION, SELECTED YEARS 1955-1956 TO 1961-1962

Type of Institution	Percentage of Federal Research Funds Allocated to Type of Institution			
	1955-56	1957-58	1959-60	1961-62
All Institutions	100.0	100.0	100.0	100.0
Public	42.2	43.6	43.9	42.9
Private	57.8	56.4	56.1	57.1
Universities	77.7	76.8	79.1	75.2
Public	41.0	42.4	42.3	41.1
Private	36.7	34.4	36.8	34.1
Liberal Arts Colleges	1.5	1.5	2.2	2.4
Public	0.3	0.3	0.5	0.6
Private	1.2	1.2	1.7	1.8
Technological Schools	19.9	19.8	16.9	19.7
Public	0.2	0.3	0.5	0.4
Private	19.7	19.5	16.4	19.3
All Others	0.9	1.9	1.8	2.7

Basic source: U.S. Office of Education, Statistics of Higher Education, 1955-56 edition, Table 3, p. 10; 1957-58 edition, Table 10, p. 22; 1959-60 edition, Table 11, p. 29; 1961-62 edition, unpublished Office of Education tables.

[a]Includes research and development at institutions proper and related contract centers. Excludes funds for research at land-grant institutions.

10 percent of total expenditures in 1949-50. They nearly doubled again from 1949-50 to 1959-60, and in 1963-64 constituted about 27 percent of total expenditures. As indicated in Table 8, in 1964, universities and colleges spent an estimated $2,778,300,000 for instructional purposes, and $1,971,300,000 for organized research purposes.

As indicated in Table 9, the federal government now pays for most of the organized research conducted at universities and colleges. Federal funds as a percentage of expenditures for organized research rose from 69 percent in 1951-52 to an estimated 90 percent in 1963-64.

Funds Allocated to Universities Proper and Funds Allocated to Related Contract Centers

In analyzing federal research funds allocated to universities and colleges, it is customary to distinguish between funds allocated to universities proper, and funds allocated to research centers managed by universities.[1] In general, funds allocated to universities and colleges proper are considered as funds for research by regular faculty members, while funds allocated to research centers

[1] In general, see National Science Foundation, Methodology of Statistics on Research and Development. See also, National Academy of Sciences, Basic Research and National Goals, Appendix A.

TABLE 9

INCOME FROM FEDERAL RESEARCH[a] FUNDS AS A PERCENTAGE OF EXPENDITURES FOR ORGANIZED RESEARCH 1951-1952 TO 1963-1964 (in thousands of dollars)

Year	Income from Federal Research Funds	Expenditures for Organized Research[b]	Income from Federal Research Funds as a Percentage of Expenditures for Organized Research
1951-52	$ 221,105	$ 320,362	69.0
1953-54	282,379	374,922	75.3
1955-56	355,576	506,097	70.3
1957-58	534,389	733,887	72.8
1959-60	828,734	1,024,399	80.9
1961-62	1,274,364	1,481,377	86.0
1963-64[c]	1,776,400	1,971,300	90.1

Basic source: U.S. Office of Education, Digest of Educational Statistics, 1964 edition, Table 80, p. 98 and Table 85, p. 101, and 1965 edition, Table 76, p. 97 and Table 81, p. 103.

[a]Includes research and development at institutions proper and related contract centers. Excludes funds for research at land-grant institutions.

[b]Funds separately budgeted by reporting institutions for research purposes.

[c]Estimated on the basis of initial reports.

TABLE 8

EXPENDITURES OF INSTITUTIONS OF HIGHER EDUCATION: TOTAL FOR EDUCATIONAL AND GENERAL PURPOSES, AND FOR ORGANIZED RESEARCH, SELECTED YEARS, 1929-1930 TO 1963-1964

Year	Expenditures in Millions			Organized Research as a Percentage of	
	Total Expenditures[a]	Educational and General Expenditures[b]	Organized Research Expenditures[c]	Total Expenditures	Educational and General Expenditures
1929-30	508.5	379.1	18.1	3.5	4.8
1939-40	678.6	525.5	28.1	4.1	5.4
1949-50	2,260.0	1,717.9	227.3	10.1	13.2
1951-52	2,486.2	1,933.6	320.4	12.9	16.4
1953-54	2,902.5	2,288.4	374.9	12.9	16.4
1955-56	3,524.7	2,788.8	506.1	14.3	18.1
1957-58	4,543.6	3,634.1	733.9	16.1	20.2
1959-60	5,628.0	4,536.1	1,024.4	18.2	22.6
1961-62	7,190.1	5,798.1	1,481.4	20.6	25.5
1963-64[d]	9,197.4	7,420.9	1,971.3	21.4	26.6

Basic source: U.S. Office of Education, Digest of Educational Statistics, 1965 edition, Table 82, p. 104, and Table 81, p. 103.

[a] Includes educational and general expenditures, student aid expenditures, expenditures for auxiliary enterprises, and other current expenditures.

[b] Includes general administration and general expense, instruction and departmental research, extension and public services, libraries, plant operation and maintenance, organized research, related activities, and sales and services expenditures.

[c] Funds separately budgeted by institution for research.

[d] Estimated.

are considered as funds for research by full-time researchers. These distinctions were not made in the U.S. Office of Education reports up to 1965, but have been made by the National Science Foundation in its annual reports on agency obligation for research and development, Federal Funds for Research, Development, and Other Scientific Activities.

NSF's reports of obligations made by federal agencies to universities and colleges for research and development in the period fiscal years 1956 to 1966 indicate that of a total of over $11.5 billion obligated to universities and colleges by federal agencies, over $7 billion, or 62 percent, were obligated to universities and colleges proper, while over $4 billion were obligated to research centers managed by universities. Table 10 indicates the percentage distribution between universities and colleges proper and contract research centers.

In 1965, the major university contract research centers maintained and supported by the major agencies were:[1]

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[1]See National Science Foundation, Federal Funds for Research, Development, and Other Scientific Activities, Fiscal Year 1964, 1965, and 1966, Vol. XIV (Washington: U.S. Government Printing Office, 1965), pp. 69-70.

TABLE 10

PERCENTAGE OF RESEARCH AND DEVELOPMENT FUNDS FROM ALL AGENCIES OBLIGATED TO UNIVERSITIES AND COLLEGES PROPER, AND TO RELATED CONTRACT CENTERS, 1956 TO 1966

Year	Percentage to Universities and Colleges Proper	Percentage to Contract Research Centers
1956	55.5	44.5
1957	58.0	41.9
1958	59.0	40.9
1959	57.7	42.3
1960	57.4	42.6
1961	56.2	43.8
1962	59.1	40.9
1963	57.1	42.9
1964	66.1	33.9
1965[a]	67.8	32.2
1966[a]	69.7	30.3
Entire 10-year Period	62.3 ($7,264,800,000)	37.7 ($4,396,000,000)

Source: National Science Foundation, Federal Funds for Science, Vols. VI-XI, and Federal Funds for Research, Development, and Other Scientific Activities, Vols. XII-XV.

[a]Estimated.

Department of Defense

Army

Army Mathematics Center,
University of Wisconsin

Human Resources Research Office,
George Washington University

Special Operations Research Office,
American University

Navy

Applied Physics Laboratory,
Johns Hopkins University

Applied Physics Laboratory,
University of Washington

Arctic Research Laboratory,
University of Alaska

Hudson Laboratory,
Columbia University

Navy Biological Laboratory,
University of California

Ordnance Research Laboratory,
Pennsylvania State University

Air Force

Lincoln Laboratory,
Massachusetts Institute of Technology

Atomic Energy Commission

Agricultural Research Laboratory,
University of Tennessee

Ames Laboratory,
Iowa State University of Science
and Technology

Argonne Cancer Research Hospital,
University of Chicago Medical School

Argonne National Laboratory,
University of Chicago

Biomedical Project,
University of California at Los Angeles

Biomedical Project,
University of California at Davis

Biomedical Project,
University of Rochester

Biomedical Project,
University of Utah

Cambridge Electron Accelerator
Harvard University and Massachusetts
Institute of Technology

Lawrence Radiation Laboratory,
(including the Livermore Radiation
Laboratory),
University of California

Los Alamos Scientific Laboratory,
University of California

Princeton-Pennsylvania Proton Accelerator,
Princeton University and University of
Pennsylvania

Princeton Stellerator,
Princeton University

Radiological Laboratory,
University of California
Medical Radiation Center

Stanford Linear Accelerator Laboratory,
Stanford University

National Aeronautics and Space Administration

Jet Propulsion Laboratory,
California Institute of Technology

In addition to these centers managed by individual universities, there are five centers managed by university consortia, Kitt Peak National Observatory, Arizona, supported by the National Science Foundation, and managed by the Association of Universities for Research in Astronomy, Inc.; the National Center for Atmospheric Research, supported by the National Science Foundation, and managed by the University Corporation for Atmospheric Research; the National Radio Astronomy Observatory, West Virginia, supported by the National Science Foundation, and managed by Associated Universities, Inc.;

Brookhaven National Laboratory, New York, supported by the Atomic Energy Commission and managed by Associated Universities, Inc.; and the Oak Ridge Associated Universities Center, Tennessee, supported by the Atomic Energy Commission, and managed by Oak Ridge Associated Universities.

Prior to the 1940's, several universities had engineering and research institutes that were used to conduct studies sponsored by industry and government. The present system of federally supported, university managed research centers evolved out of World War II.[1] Following the war, the government continued to support several of the laboratories, such as the Los Alamos Laboratory of the University of California and the Applied Physics Laboratory of Johns Hopkins University. In addition, new centers were created in the late 1940's and 1950's, such as the Argonne National Laboratory of the University of Chicago, the Lincoln Laboratory of Massachusetts Institute of Technology, and the Jet Propulsion Laboratory of California Institute

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[1]See Irvin Stewart, Organizing Scientific Research for War: The Administrative History of the Office of Scientific Research and Development (Boston: Little Brown, 1948). See also, U.S. Senate, Committee on Military Affairs, Government's Wartime Research and Development, Report of the Subcommittee on War Mobilization, 79th Cong., 1st Sess., 1945.

of Technology.[1]

These centers provide agencies with access to the scientific and managerial resources of the universities, without bringing scientists and engineers directly into government, with the attendant salary and other problems.[2]

These centers are not a homogeneous group. Some of them are integrated into the administrative and instructional structures of the institutions at which they are located, while others are nearly autonomous.[3]

Sources of Funds by Agencies

When total federal obligation for research and development in both universities proper and contract centers are analyzed by agency source, the results are as indicated in Table 11. From 1956 to 1966, the percentage

[1] For a brief historical sketch of these centers, and a statistical analysis of activity at these centers, see National Science Foundation, "Federal Contract Research Centers in Colleges and Universities, Fiscal Year, 1958," Reviews of Data on Research and Development, No. 23 (October, 1960).

[2] See U.S. Bureau of the Budget, Report to the President on Government Contracting for Research and Development (Washington: U.S. Government Printing Office, 1962).

[3] While no general study of these centers has been published, these centers are discussed in relation to other administrative centers used to administer research in William C. Wheadon, "Organizing University Research," Industrial Research, VI, No. 4 (April, 1964), 38.

TABLE 11

PERCENTAGE CONTRIBUTION OF MAJOR AGENCIES TO FEDERAL OBLIGATIONS FOR RESEARCH AND DEVELOPMENT IN UNIVERSITIES PROPER AND RELATED CONTRACT CENTERS, 1956 TO 1966

Agency	1956	1958	1960	1962	1964[a]	1966[a]
Department of Defense	43.3	35.1	29.9	27.6	26.7	23.2
Atomic Energy Commission	33.5	36.9	31.1	24.3	24.1	22.3
Department of Health, Education and Welfare	9.9	16.5	20.2	22.8	26.1	27.7
(National Institutes of Health)		(15.6)	(18.3)	(20.8)	(22.8)	(22.6)
National Science Foundation	3.8	4.3	7.2	6.3	7.5	10.3
National Aeronautics and Space Administration	-	-	7.0	15.4	11.6	11.9

Source: National Science Foundation, Federal Funds for Science, Vols. VI-XI, and Federal Funds for Research, Development, and Other Scientific Activities, Vols. XII-XV.

[a]Estimated.

contributed by the Department of Defense declined from 43.3 percent to 23.2 percent. The share of the Department of Health, Education, and Welfare rose from 9.9 percent in 1956 to 27.7 percent in 1966. The share of the National Science Foundation rose from 3.8 percent in 1956 to 10.3 percent in 1966.

When obligations to contract centers are excluded, and the percentage contributions of the major agencies to federal obligations for research and development in universities proper are analyzed, the results are as shown in Table 12. The share of the Department of Defense in funding research in universities proper declined from nearly 50 percent in 1956 to about 25 percent in 1966. The contribution of the Department of Health, Education, and Welfare rose from about 18 percent in 1956 to 40 percent in 1966. Over 80 percent of the Department of Health, Education, and Welfare funds throughout this period were NIH funds. The relative contribution of the National Science Foundation rose from 6 percent in 1956 to 15 percent in 1966.

TABLE 12

PERCENTAGE CONTRIBUTION OF MAJOR AGENCIES TO FEDERAL OBLIGATIONS FOR RESEARCH AND DEVELOPMENT IN UNIVERSITIES PROPER, 1956 TO 1966

Agency	1956	1958	1960	1962	1964[a]	1966[a]
Department of Defense	48.1	41.9	34.4	32.3	29.2	24.7
Atomic Energy Commission	10.7	10.7	7.5	5.8	5.6	5.5
Department of Health, Education, and Welfare	17.8	27.9	35.1	38.6	39.4	39.8
(National Institutes of Health)		(26.5)	(32.0)	(35.3)	(34.5)	(32.4)
National Science Foundation	6.3	7.3	12.5	10.7	11.3	14.7
National Aeronautics and Space Administration	-	-	2.3	6.7	8.4	8.8

Source: National Science Foundation, Federal Funds for Science, Vols. VI-XI, and Federal Funds for Research, Development, and Other Scientific Activities, Vols. XII-XV.

[a]Estimated

In analyzing federal research funds it is necessary to distinguish between funds for basic research on the one hand, and funds for applied research and development on the other, although the validity of this distinction as it applies to research performed at universities and colleges is often questioned.[1]

As is indicated in Table 13, universities and colleges in the United States in the period 1953-63 used about 9 percent of all research and development funds, federal and otherwise, spent in the United States. In the same period, the universities and colleges used about 46 percent of the total funds spent on basic research in the United States, as indicated in Table 14.

As is indicated in Table 15, about 45 percent of the total obligated by federal agencies for basic research is obligated to educational institutions. The remaining 55 percent is obligated to not-for-profit research institutions, industry, and government laboratories. As Table 16 shows, funds for basic research have, in the 1960's, constituted about 54 percent of all federal research and development

[1] See, e.g., Harvey Brooks, "Future Needs for the Support of Basic Research," in National Academy of Sciences, Basic Research and National Goals, pp. 80-83.

TABLE 13

RESEARCH AND DEVELOPMENT FUNDS USED IN UNIVERSITIES AND COLLEGES[a] AS A PERCENTAGE OF ALL RESEARCH AND DEVELOPMENT FUNDS USED IN THE UNITED STATES, 1953 TO 1963
(in millions of dollars)

Year	Total Research and Development Funds, All Performers	Research and Development Funds Used in Universities and Colleges	Research and Development Funds Used in Universities and Colleges as a Percentage of Total Research and Development Funds
1953	5,160	420	8.1
1954	5,660	450	8.0
1955	6,200	480	7.7
1956	8,370	530	6.3
1957	9,810	650	6.6
1958	10,810	780	7.2
1959	12,430	840	6.8
1960	13,620	1,000	7.3
1961	14,380	1,200	8.3
1962[b]	15,610	1,400	10.0
1963[b]	17,350	1,700	9.8

Basic source: National Science Foundation, "Research Funds Used in the Nation's Scientific Endeavor," Reviews of Data on Science Resources, I, No. 4 (May, 1965), 6.

[a] Includes contract centers.

[b] Preliminary.

TABLE 14

BASIC RESEARCH FUNDS USED IN UNIVERSITIES AND COLLEGES[a] AS A PERCENTAGE OF ALL BASIC RESEARCH FUNDS USED IN THE UNITED STATES, 1953 TO 1963
(in millions of dollars)

Year	Basic Research Funds Used in the United States	Basic Research Funds Used in Universities and Colleges	Basic Research Funds Used in Universities and Colleges As a Percentage of All Basic Research Funds Used in the United States
1953	412	190	46.1
1954	455	208	45.7
1955	517	230	44.5
1956	619	250	40.4
1957	721	300	41.6
1958	882	392	44.4
1959	992	420	42.3
1960	1,135	500	44.1
1961	1,324	575	43.4
1962[b]	1,575	695	44.1
1963[b]	1,815	840	46.3

Basic source: National Science Foundation, "Research Funds Used in the Nation's Scientific Endeavor," Reviews of Data on Science Resources, I, No. 4 (May, 1965), 7.

[a] Includes contract centers.

[b] Preliminary.

TABLE 15

AMOUNTS AND PERCENTAGES OF ALL FEDERAL OBLIGATIONS FOR BASIC RESEARCH OBLIGATED TO EDUCATIONAL INSTITUTIONS,[a] 1958 TO 1966
(in millions of dollars)

	1958	1959	1960	1961	1962	1963	1964	1965[b]	1966[b]
Amount of federal obligations for basic research, all performers	336	519	612	827	1,110	1,395	1,574	1,808	2,049
Amount of federal obligations for basic research to educational institutions	152	225	294	381	509	613	699	801	952
Percentage of all federal obligations for basic research obligated to educational institutions	45	43	48	46	46	44	44	44	46

Computed from National Science Foundation, Federal Funds for Research, Development, and Other Scientific Activities, Fiscal Years 1964, 1965, and 1966, Vol. XIV, Table C-55, p. 149.

[a] Includes contract centers.

[b] Estimated.

TABLE 16

FEDERAL BASIC RESEARCH[a] FUNDS AS A PERCENTAGE OF ALL FEDERAL RESEARCH AND DEVELOPMENT FUNDS OBLIGATED TO UNIVERSITIES AND COLLEGES PROPER, 1958 TO 1966
(in millions of dollars)

Year	Federal Research and Development Funds Obligated to Universities and Colleges Proper	Federal Basic Research Funds Obligated to Universities and Colleges Proper	Federal Basic Research Funds as a Percentage of Federal Research and Development Funds Obligated to Universities and Colleges Proper
1958	282	122	43.3
1959	356	180	50.6
1960	449	239	53.2
1961	540	287	53.1
1962	802	374	46.6
1963	855	463	54.2
1964	1,061	552	52.0
1965[b]	1,178	633	53.7
1966[b]	1,350	757	56.1

Computed from National Science Foundation, Federal Funds for Research, Development, and Other Scientific Activities, Fiscal Years 1964, 1965, and 1966, Vol. XIV, Table C-55, p. 149.

[a]Includes contract centers.

[b]Estimated.

funds allocated to universities and colleges proper. Funds for applied research have constituted about 30 percent and funds for development about 15 percent.

The Distribution of Federal Academic Research Funds

As noted in Chapter I, an extensive analysis of the obligations by major federal agencies to institutions of higher education of funds for all purposes has been undertaken by the Committee on Academic Science and Engineering of the Federal Council for Science and Technology, as a direct response to the President's Memoranda. The following data are derived from the committee's first report, published in August 1966.[1]

The data presented in this report were provided by the eight departments and agencies that in 1965 accounted for over 95 percent of all federal support to universities and colleges. These departments and agencies were the Department of Agriculture, the Atomic Energy Commission, the Department of Commerce, the Department of Defense, the Department of Health, Education, and Welfare, the Department

[1] National Science Foundation, Federal Support for Academic Science and Other Educational Activities in Universities and Colleges, Fiscal Year 1965, a report prepared by the National Science Foundation for the Office of Science and Technology (Washington: National Science Foundation, 1966).

of Interior, the National Aeronautics and Space Administration, and the National Science Foundation.

In 1965, total federal support to universities and colleges amounted to $2.3 billion. This support took four forms, (1) research and development, $1,076 million, or 47 percent, (2) research and development plant and facilities, $126 million, or 6 percent, (3) other academic-science activities related to research and development, $528 million, or 23 percent, and (4) other educational activities, $543 million, or 24 percent. The category "other academic-science activities" consists primarily of funds provided directly for science education and training related to research, such as direct student support and course content improvement projects. This category also included $11 million reported by NSF as institutional support, that is, support provided directly to institutions for operating purposes, as distinguished from support provided to individual investigators or students, and funds provided to institutions for the construction of specifically designated facilities. NSF was the only agency that reported funds

for institutional support. The category "other educational activities" consists entirely of Department of Health, Education and Welfare funds. About 65 percent of the amount in this category was for the construction and original equipping of undergraduate facilities through Office of Education programs, and about 30 percent was for fellowship funds and training funds in fields other than science.

In other terms, funds for academic science--research and development, research and development plant, and related science education and training--constituted 76 percent of total federal support, while funds for other educational activities--undergraduate facility construction and fellowships in fields other than science--constituted 24 percent.

As is indicated in Table 17, the Department of Health, Education, and Welfare provided 58.6 percent of total federal funds, the National Science Foundation 14.3 percent, the Department of Defense 11.6 percent, the Department of Agriculture 6.0 percent, and the National Aeronautics and Space Administration 5.2 percent. The Department of Health, Education, and Welfare also led in

the provision of funds for academic science with 45.7 percent, followed by the National Science Foundation with 18.8 percent, the Department of Defense with 15.3 percent, the Department of Agriculture with 7.8 percent, and the National Aeronautics and Space Administration with 6.8 percent. Finally, in the direct support of research and development HEW provided 41.1 percent, DOD provided 24.6 percent, NSF 12.9 percent, NASA 7.8 percent, and AEC 7.0 percent. The dominance of HEW in academic science in general, and research and development in particular, is attributable to the role of the National Institutes of Health, which account for over 90 percent of HEW's academic science funds.

As indicated in Table 18, 69 percent of all federal funds and 74 percent of federal research and development funds in 1965 were obligated to 15 states with 65 percent of the population. California, New York, Illinois, Massachusetts, and Maryland each received a percentage of the total funds larger than the state's percentage of total population. The question of the standards that should be

used to measure equity in fund distribution is discussed below in Chapter IV. The variations among agency

TABLE 18

FEDERAL SUPPORT TO UNIVERSITIES AND COLLEGES IN THE FIFTEEN STATES RECEIVING THE LARGEST AMOUNT OF FEDERAL FUNDS, 1965

State	Percent of Total Population	Percent of Total Federal Funds	Percent of Total Research & Development Funds
California	9	12	13
New York	9	12	13
Pennsylvania	6	5	5
Illinois	5	6	6
Texas	5	4	4
Ohio	5	4	4
Michigan	4	4	5
Massachusetts	3	7	9
North Carolina	3	2	2
New Jersey	3	2	2
Florida	3	2	2
Maryland	2	3	3
Indiana	2	2	2
Wisconsin	2	2	2
Minnesota	2	2	2
Total	65	69	74

Source: National Science Foundation, Federal Support for Academic Science and Other Educational Activities in Universities and Colleges, Fiscal Year 1965, Chart 2, p. 13 and Table B-1, pp. 40-41.

TABLE 17

TOTAL FEDERAL SUPPORT TO UNIVERSITIES AND COLLEGES,
BY AGENCY AND TYPE OF SUPPORT, 1965
(dollar amounts in millions)

Agency	Total		Academic Science								Other Educational Activities[a]	
			Total		Research & Development		R&D Plant		Other			
	Amount	Percent	Amount	Percent	Amount	Percent	Amount	Percent	Amount	Percent	Amount	Percent
Total	$2,273.4	100.0	$1,730.1	100.0	$1,075.6	100.0	$126.2	100.0	$528.4	100.0	$543.2	100.0
Department of Agriculture	135.6	6.0	135.6	7.8	59.1	5.5	3.2	2.6	73.3	13.9	b	c
Atomic Energy Commission	84.4	3.7	84.4	4.9	74.8	7.0	3.8	3.0	5.9	1.1	-	-
Department of Commerce	2.6	.1	2.6	.2	2.1	.2	-	-	.6	.1	-	-
Department of Defense	264.8	11.6	264.8	15.3	264.8	24.6	-	-	-	-	-	-
Department of Health, Education and Welfare	1,333.3	58.6	790.2	45.7	442.2	41.1	54.8	43.4	293.2	55.5	543.1	100.0
Department of the Interior	9.7	.4	9.6	.6	9.5	.9	b	c	b	c	.1	c
National Aeronautics and Space Administration	117.7	5.2	117.7	6.8	83.9	7.8	8.4	6.6	25.4	4.8	-	-
National Science Foundation	325.2	14.3	325.2	18.8	139.1	12.9	56.0	44.4	130.1	24.6	-	-

Reproduced from National Science Foundation, Federal Support for Academic Science and Other Educational Activities in Universities and Colleges, Fiscal Year, 1965, Table 1, p. 7.

[a] These obligations for other educational activities represent, in large part, the program of the Office of Education for construction and initial equipping of undergraduate facilities.

[b] Less than $50,000.
[c] Less than 0.05 percent.

obligations for total support to these fifteen states were as follows:

Department of Defense	83.1%
Atomic Energy Commission	78.1%
Department of Commerce	76.3%
National Aeronautics and Space Administration	73.8%
National Science Foundation	68.7%
Department of Agriculture	40.9%

Of the 2,237 universities and colleges in the United States, 1,458 received some form of federal support in 1965. Nine hundred and sixty-five institutions received some form of federal academic science support, while 565 received support for research and development as such. However, as indicated in Table 19, 100 universities and colleges received 77.4 percent of total federal support, while the same 100 institutions received 85.4 percent of the academic science support.[1] The amount of federal support in states and regions is in good part determined by the concentration of funds in a few institutions. For example, Massachusetts Institute of Technology and Harvard University accounted for about 70 percent of total federal

[1]The CASE report did not give figures on the research and development support received by individual institutions.

support to the 104 institutions of higher education in Massachusetts. Fourteen institutions in Massachusetts offer Ph.D. degrees, and an additional 29 offer master's degrees. In California, three institutions, U.C.L.A., Stanford, and the University of California, Berkeley, of a total of 178 institutions of which 64 offer advanced degrees, received about 50 percent of the funds. A similar situation pertains in New York, where three institutions, Columbia, Cornell, and New York University, of 191 institutions of which 77 offer advanced degrees, received about 50 percent of the funds. A similar pattern pertains in most states.

As is indicated in Tables 20 and 21, federal support of academic science is more heavily concentrated than total federal support. In the case of academic science funds, the first 10 institutions received 25 percent of all funds, while in the case of all support the first 10 institutions received 21.3 percent of the funds. In academic science the first 50 received 66.4 percent and the first 100 received 86.3 percent, while in total

TABLE 19

ONE HUNDRED UNIVERSITIES AND COLLEGES RECEIVING THE LARGEST AMOUNTS OF FEDERAL SUPPORT, 1965
(Thousands of dollars)

Institution (ranked according to Federal support)	Total Support[a]		Academic Science Support[a]	
	Amount	Percent of Total	Amount	Percent of Total
1. Massachusetts Inst. of Tech. (Mass.)	$59,601	2.6	$59,410	3.4
2. Univ. of Michigan (Mich.)	58,805	2.6	50,239	2.9
3. Univ. of California-Los Angeles (Calif.)	51,884	2.3	35,434	2.0
4. Columbia Univ. (N.Y.)	51,793	2.3	45,681	2.6
5. Cornell Univ. (N.Y.)	48,858	2.1	47,769	2.8
6. Univ. of Illinois (Ill.)	44,892	2.0	40,525	2.3
7. Univ. of California-Berkeley (Calif.)	43,561	1.9	39,753	2.3
8. Stanford Univ. (Calif.)	42,703	1.9	39,101	2.3
9. Univ. of Minnesota-Minneapolis/St. Paul	41,765	1.8	35,855	2.1
10. Harvard Univ. (Mass.)	40,802	1.8	39,344	2.3
11. Univ. of Wisconsin-Madison (Wisc.)	39,789	1.8	33,442	1.9
12. New York Univ. (N.Y.)	36,571	1.6	29,858	1.7
13. Univ. of Washington (Wash.)	36,082	1.6	33,236	1.9
14. Univ. of Chicago (Ill.)	35,692	1.6	34,907	2.0
15. Johns Hopkins Univ. (Md.)	33,198	1.5	29,492	1.7
16. Univ. of Pennsylvania (Pa.)	32,710	1.4	30,500	1.8
17. Univ. of Texas (Tex.)	32,400	1.4	26,557	1.5
18. Yale Univ. (Conn.)	26,488	1.2	24,986	1.4
19. Ohio State Univ.(O.)	25,388	1.1	22,642	1.3
20. Univ. of Maryland (Md.)	25,192	1.1	17,704	1.0

TABLE 19--Continued

Institution (ranked according to Federal support)	Total Support[a]		Academic Science Support[a]	
	Amount	Percent of Total	Amount	Percent of Total
21. Western Reserve Univ. (O.)	$23,597	1.0	$18,520	1.1
22. Univ. of Pittsburgh (Pa.)	22,825	1.0	17,869	1.0
23. Univ. of Colorado (Colo.)	22,813	1.0	19,705	1.1
24. Purdue Univ. (Ind.)	21,575	.9	18,238	1.1
25. Washington Univ. (Mo.)	20,316	.9	18,900	1.1
26. Univ. of Southern California (Calif.)	20,313	.9	15,322	.9
27. Yeshiva Univ. (N.Y.)	19,950	.9	17,600	1.0
28. Indiana Univ. (Ind.)	19,513	.9	14,061	.8
29. Rutgers Univ. (N.J.)	19,107	.8	13,111	.8
30. Pennsylvania State Univ. (Pa.)	18,985	.8	14,298	.8
31. Univ. of California-San Diego (Calif.)	18,842	.8	10,787	.6
32. Univ. of Rochester (N.Y.)	18,501	.8	17,925	1.0
33. Duke Univ. (N.C.)	18,422	.8	16,469	1.0
34. Princeton Univ. (N.J.)	18,158	.8	17,712	1.0
35. Univ. of Florida (Fla.)	18,153	.8	15,414	.9
36. Univ. of Oregon (Ore.)	17,361	.8	14,968	.9
37. California Inst. of Tech. (Calif.)	17,287	.8	17,172	1.0
38. Northwestern Univ. (Ill.)	17,175	.8	13,696	.8
39. Howard Univ. (D.C.)[b]	15,648	.7	2,351	.1
40. Univ. of Missouri (Mo.)	14,972	.7	12,278	.7

TABLE 19--Continued

Institution (ranked according to Federal support)	Total Support[a]		Academic Science Support[a]	
	Amount	Percent of Total	Amount	Percent of Total
41. Univ. of Utah (Utah)	$14,722	.6	$12,646	.7
42. Michigan State Univ. (Mich.)	14,415	.6	12,168	.7
43. Univ. of Miami (Fla.)	14,334	.6	12,167	.7
44. Univ. of Tennessee (Tenn.)	14,309	.6	12,356	.7
45. Tulane Univ. of Louisiana (La.)	14,218	.6	11,321	.7
46. Loyola Univ. (Ill.)	13,385	.6	3,692	.2
47. Univ. of Puerto Rico (P.R.)	13,065	.6	9,632	.6
48. Univ. of N.C. at Chapel Hill (N.C.)	13,019	.6	11,123	.6
49. Univ. of California-San Francisco (Calif.)	12,997	.6	12,661	.7
50. Univ. of Virginia (Va.)	12,592	.6	11,223	.6
51. Texas A&M Univ. (Tex.)	12,477	.5	11,824	.7
52. Univ. of Iowa (Ia.)	12,475	.5	10,376	.6
53. Univ. of Kansas (Kan.)	12,217	.5	10,036	.6
54. Univ. of California-Davis (Calif.)	11,931	.5	9,239	.5
55. Univ. of Kentucky (Ky.)	11,738	.5	9,912	.6
56. Univ. of Arizona (Ariz.)	11,597	.5	9,514	.5
57. Georgetown Univ. (D.C.)	11,494	.5	5,566	.3
58. Univ. of Georgia (Ga.)	11,296	.5	9,304	.5
59. Syracuse Univ. (N.Y.)	11,250	.5	10,326	.6
60. Univ. of Hawaii (Hawaii)	10,985	.5	8,165	.5
61. Univ. of Vermont & State Agr. Col. (Vt.)	10,718	.5	5,771	.3
62. Univ. of Nebraska (Nebr.)	10,718	.5	6,656	.4

TABLE 19--Continued

Institution (ranked according to Federal support)	Total Support[a]		Academic Science Support[a]	
	Amount	Percent of Total	Amount	Percent of Total
63. Univ. of N.C. State at Raleigh (N.C.)	$10,493	.5	$ 9,797	.6
64. Oregon State Univ. (Ore.)	10,369	.5	9,182	.5
65. Louisiana State Univ. & A&M Col. (La.)	9,995	.4	8,152	.5
66. Baylor Univ. (Tex.)	9,770	.4	9,466	.5
67. Boston Univ. (Mass.)	9,649	.4	7,314	.4
68. Iowa State Univ. of Sci. & Tech. (Ia.)	9,559	.4	9,114	.5
69. Wayne State Univ. (Mich.)	9,420	.4	6,704	.4
70. Emory Univ. (Ga.)	9,217	.4	6,978	.4
71. Univ. of Alabama (Ala.)	9,103	.4	7,204	.4
72. Univ. of Oklahoma (Okla.)	8,986	.4	7,809	.5
73. Case Inst. of Tech. (O.)	8,868	.4	8,743	.5
74. Vanderbilt Univ. (Tenn.)	8,540	.4	8,001	.5
75. Rice Univ. (Tex.)	8,256	.4	7,003	.4
76. Brown Univ. (R.I.)	8,244	.4	7,923	.5
77. Colorado State Univ. (Colo.)	8,231	.4	7,321	.4
78. Okla. State Univ. of Agri. & App. Sci.	8,024	.4	6,609	.4
79. Florida State Univ. (Fla.)	7,638	.3	5,366	.3
80. University of Arkansas (Ark.)	7,619	.3	7,100	.4
81. Univ. of Massachusetts (Mass.)	7,494	.3	6,349	.4
82. West Virginia Univ. (W.Va.)	7,228	.3	6,407	.4
83. Georgia Inst. of Tech. (Ga.)	7,164	.3	5,703	.3

TABLE 19--Continued

Institution (ranked according to Federal support)	Total Support[a]		Academic Science Support[a]	
	Amount	Percent of Total	Amount	Percent of Total
84. George Washington Univ. (D.C.)	$ 7,059	.3	$ 6,169	.4
85. Auburn Univ. (Ala.)	7,045	.3	6,208	.4
86. Tufts Univ. (Mass.)	7,030	.3	5,731	.3
87. State Univ. of N.Y. at Buffalo (N.Y.)	6,825	.3	6,460	.4
88. Carnegie Inst. of Tech. (Pa.)	6,618	.3	6,356	.4
89. Mississippi State Univ. (Miss.)	6,577	.3	5,342	.3
90. Kansas State Univ. of Agr. & App. Sci.	6,545	.3	5,013	.3
91. Temple Univ. (Pa.)	6,491	.3	5,001	.3
92. Univ. of New Mexico (N.Mex.)	6,480	.3	3,606	.2
93. New Mexico State Univ. (N. Mex.)	6,292	.3	5,808	.3
94. Univ. of Mississippi (Miss.)	6,046	.3	3,174	.2
95. Univ. of Connecticut (Conn.)	6,005	.3	3,978	.2
96. Univ. of Denver (Colo.)	5,989	.3	5,391	.3
97. Washington State Univ. (Wash.)	5,889	.3	5,274	.3
98. Virginia Polytechnic Inst. (Va.)	5,873	.3	5,507	.3
99. Gallaudet Col. (D.C.)[b]	5,842	.3	342	c
100. Univ. of Houston (Tex.)	5,747	.3	1,852	.1
Total for 100 universities and colleges	$1,759,859	77.4	$1,477,966	85.4

Reproduced from National Science Foundation, Federal Support for Academic Science and Other Educational Activities in Universities and Colleges, Fiscal Year 1965, Table V, pp. 21-23.

[a]The differences between "total support" and "academic science support" are funds for other educational activities consisting in large part of the Office of Education's program for construction and initial equipping of undergraduate facilities.

[b]These obligations for Howard University and Gallaudet College are Federal appropriations for the operation of the institutions.

[c]Less than .05 percent.

support the first 50 received 58.4 percent, and the first 100 received 77.4 percent.

TABLE 20

TOTAL FEDERAL SUPPORT TO THE ONE HUNDRED UNIVERSITIES AND COLLEGES RECEIVING THE LARGEST AMOUNTS OF FEDERAL FUNDS, 1965
(dollar amounts in millions)

Institutions Arrayed from Highest to Lowest in Terms of Federal Funds Received	Amount	Percentage Distribution
First 10	$ 484.7	21.3
Second 10	323.5	14.2
Third 10	209.0	9.2
Fourth 10	174.5	7.7
Fifth 10	137.1	6.0
First 50	1,328.7	58.4
Second 50	431.1	19.0
First 100	1,759.9	77.4
All other	513.5	22.6
Total, all institutions	2,273.4	100.0

Source: National Science Foundation, Federal Support for Academic Science and Other Educational Activities in Universities and Colleges, Fiscal Year 1965, Table VI, p. 24.

TABLE 21

FEDERAL ACADEMIC SCIENCE SUPPORT TO THE ONE HUNDRED UNIVERSITIES AND COLLEGES RECEIVING THE LARGEST AMOUNTS OF SUPPORT, 1965
(dollar amounts in millions)

Institutions Arrayed from Highest to Lowest in Terms of Federal Funds Received	Amount	Percentage Distribution
First 10	$ 433.1	25.0
Second 10	285.3	16.5
Third 10	178.1	10.3
Fourth 10	138.5	8.0
Fifth 10	113.6	6.6
First 50	1,148.7	66.4
Second 50	343.8	19.9
First 100	1,492.5	86.3
All other	237.6	13.7
Total, all institutions	1,730.1	100.0

Source: National Science Foundation, Federal Support for Academic Science and Other Educational Activities in Universities and Colleges, Fiscal Year 1965, Table VII, p. 25.

Finally, as is indicated in Table 22, there is substantial variation among agencies in the concentration of total funds in the leading institutions. To some extent, these variations reflect the differences in agency missions. The Department of Defense obligated 41.8 percent of its funds

to the first ten institutions, NASA, 35.1 percent of its funds, and AEC, 27.3 percent of its funds. In contrast, NSF obligated 23.5 percent to the first ten, HEW, 16.2 percent, and agriculture, 11.3 percent. However, every agency obligated over 70 percent to the leading one hundred institutions.

Summary and Conclusions of Chapter II

In summary of Chapter II, the federal academic research funding system has had a major impact in the financing of the processes of higher education in the United States since the early 1950's. In 1964, all identifiable federal funds composed 22.4 percent of the current income of institutions of higher education in the United States. This is the highest percentage of current income ever composed of federal funds. This 22.4 percent contribution from federal agencies matched the contribution from state governments, traditionally the source of the greatest support of higher education income. About 83 percent of all federal funds are

TABLE 22

INDIVIDUAL AGENCY SUPPORT TO THE ONE HUNDRED UNIVERSITIES AND COLLEGES RECEIVING THE LARGEST AMOUNTS OF FEDERAL FUNDS, BY AGENCY, 1965

Institutions Arrayed from Highest to Lowest in Terms of Federal Support Received[a]	Total	Dept. of Agri-culture	AEC	Dept. of Commerce	DOD	HEW	Dept. of Interior	NASA	NSF
First 10									
Millions of dollars	$ 484.7	$ 15.3	$23.1	$0.5	$110.8	$ 216.2	$1.2	$41.3	$76.4
Percent of total	21.3%	11.3%	27.3%	19.9%	41.8%	16.2%	12.1%	35.1%	23.5%
First 20									
Millions of dollars	808.2	25.6	40.9	.8	151.1	416.3	1.9	58.3	113.2
Percent of total	35.5	18.9	48.5	32.4	57.0	31.2	19.8	49.5	34.8
First 30									
Millions of dollars	1,017.2	35.4	45.8	1.2	164.2	551.7	2.5	66.4	149.9
Percent of total	44.7	26.1	54.3	47.9	62.0	41.4	26.0	56.4	46.1
First 40									
Millions of dollars	1,191.7	41.2	57.7	1.3	184.4	643.2	2.8	77.2	184.0
Percent of total	52.4	30.4	68.3	48.3	69.6	48.2	28.6	65.6	56.6
First 50									
Millions of dollars	1,328.7	52.0	64.4	1.3	192.7	735.8	3.3	80.1	199.0
Percent of total	58.4	38.4	76.2	50.3	72.8	55.2	34.3	68.1	61.2
First 100									
Millions of dollars	1,759.9	119.0	77.2	1.9	231.7	962.6	6.9	105.7	254.9
Percent of total	77.4	87.7	91.4	72.5	87.5	72.2	71.1	89.8	78.4
Total all institutions									
Millions of dollars	$2,273.4	$135.6	$84.4	$ 2.6	$264.8	$1,333.3	$ 9.7	$117.7	$325.2
Percent of total	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

Reproduced from National Science Foundation, Federal Support for Academic Science and Other Educational Activities in Universities and Colleges, Fiscal Year 1965, Table VIII, p. 26.

[a]Institutions are ranked from highest to lowest in terms of the total dollar volume of support from all Federal sources.

classified by the institutions receiving the funds as funds for research. Agency figures indicate that in 1965 about 76 percent of total agency obligations to institutions were for academic science, that is, research, research facility construction, and research-related educational processes. These funds were highly concentrated in about 100 institutions.

In order to understand how this concentration materialized, it is necessary to examine the basic policies and procedures followed by federal agencies in funding academic research and related activities. These policies and procedures are analyzed in Chapter III.

CHAPTER III

THE LEGAL AND ADMINISTRATIVE DECISION-MAKING PATTERNS USED BY FEDERAL AGENCIES TO FUND ACADEMIC RESEARCH

The data in Chapter II indicate in quantitative terms the extent of the involvement of federal agencies with institutions of higher education through research funding programs. The purpose of this chapter is to analyze the legal and administrative decision-making processes by which this involvement has been effected. In the American constitutional system these decision-making processes are the means by which the political power of the federal government has been related to the intellectual resources of universities for the achievement of public purposes. The President's Memoranda raise the question of the merits and demerits of these various decision-making processes. The arguments about the merits and demerits of these processes are analyzed in Chapter IV.

The American Constitutional System and the Federal Academic Research Funding System

Both by tradition and by the provisions of the United States Constitution, direct responsibility for higher

education and for academic research in the United States is a province of state and local governments, and private organizations and individuals.[1] At the Constitutional Convention, Charles Pickney introduced a number of proposals designed to authorize federal support of higher education and related research processes, including proposals to "establish seminaries for the promotion of literature, and the arts and sciences," to "grant charters of incorporation" to scientific societies, to grant patents for useful inventions, and to "establish public institutions, rewards and immunities for the promotion of agriculture, commerce, trades, and manufactures."[2] Pickney and Madison also proposed establishment of a national university.[3]

Although the available evidence indicates that the

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[1]For a history of higher education in the United States, and the relationship of scientific research to higher education, see Frederick Rudolph, The American College and University (New York: Vintage Press, 1965). See also, Charles Weiner, "Science and Higher Education," Science and Society in the United States, ed. David Van Tassel and Michael Hall (Homewood, Ill.: The Dorsey Press, 1966), pp. 163-90.

[2]Max Farrand, The Records of the Federal Convention of 1787 (New Haven: Yale University Press, 1935), Vol. II, p. 325.

[3]Ibid., p. 615. See also, Edgar Wesley, Proposed: The University of the United States (Minneapolis: University of Minnesota Press, 1936), and Robert D. Calkins, "The National University," Science, CLII, No. 3724 (May 13, 1966), 152-53.

members of the Constitutional Convention favored federal encouragement of scientific research and higher education as these existed at the time,[1] the patent provision was the only one of these provisions incorporated into the Constitution.[2]

Despite the absence of direct constitutional authorization to do so, the federal government has supported various aspects of higher education and academic research throughout its history.[3] Chart I sets forth by year and purpose the

[1] For the background of federal-science relationships in the early years of the United States, see Theodore Horberger, Scientific Thought in the American Colleges, 1638-1800 (Austin: University of Texas Press, 1945); Whitfield J. Bell, "The Scientific Environment of Philadelphia, 1775-1790," American Philosophical Society, Proceedings, Vol. 92, No. 1 (1948), p. 10; Madge E. Pickard, "Government and Science in the United States: Historical Backgrounds," Journal of the History of Medicine, I (April, 1946), 254; A. Hunter Dupree, Science in the Federal Government (New York: Harper and Row, 1964). See also, Richard Harrison Shryock, "American Indifference to Basic Science During the Nineteenth Century," Archives Internationales d'Histoire des Sciences, No. 28 (1948-49), pp. 3-18, reprinted in The Sociology of Science, ed. Bernard Barber and Walter Hirsch (New York: The Free Press of Glencoe, 1962), pp. 98-110.

[2] U.S. Constitution, Article I, Sec. 8.

[3] See Alice M. Rivlin, The Role of the Federal Government in Financing Higher Education (Washington: The Brookings Institution, 1961). See also, Homer D. Babbidge, Jr., and Robert M. Rosenzweig, The Federal Interest in Higher Education (New York: McGraw-Hill, 1962); U.S. Congress, House Committee on Education and Labor, The Federal Government and Education, Report of the Special Subcommittee on Education, 88th Cong., 1st Sess., 1963; Seymour E. Harris, Higher Education: Resources and Finances (New York: McGraw-Hill, 1962); Seymour E. Harris, Education and Public Policy (Berkeley: McCutchan Publishing Co., 1965).

major acts of Congress designed to support processes of higher education in the United States. These acts are based either on an exercise by Congress of one of the specific powers conferred upon it by Article I, Section 8 of the Constitution, or on the general welfare clause of Article I, Section 8. For the most part these acts have been designed to support specific aspects of higher education of particular concern to the federal government at a particular time, rather than to support higher education in and of itself in the judgment that it would be in the national interest to do so.

CHART I

MAJOR ACTS OF CONGRESS DESIGNED TO SUPPORT VARIOUS ASPECTS OF HIGHER EDUCATION IN THE UNITED STATES, TO 1965

Year	Act and Purpose
1787	Northwest Ordinance--land grants for the establishment of educational institutions
1862	First Morrill Act--public land grants to the States for the establishment and maintenance of agricultural and mechanical colleges.
1874	Aid to State nautical schools--matching funds for State nautical schools

1890	Second Morrill Act--money grants for support of instruction in the agricultural and mechanical colleges
1917	Smith-Hughes Act--grants to States for support of vocational education
1918	Vocational Rehabilitation Act--funds for rehabilitation of World War I veterans
1919	Federal surplus property--use of federal surplus property by educational institutions authorized
1920	Smith-Bankhead Act--grants to States for vocational rehabilitation programs
1935	Bankhead-Jones Act--grants to States for Agricultural Experiment Stations
1937	National Cancer Institute Act--established Public Health Service Fellowship program
1943	Vocational Rehabilitation Act--provided assistance to disabled veterans
1944	Serviceman's Readjustment Act--provided assistance for education of veterans
	Surplus Property Act--authorized transfer of surplus property to educational institutions
1946	George-Barden Act--expanded federal support of vocational education
1949	Federal Property and Administrative Services Act--provided for donation of surplus property to educational institutions and for other public uses

1950	Housing Act--loans for construction of college housing facilities
	National Science Foundation Act--authorized grants for scientific research and science education
1954	Cooperative research in education--authorized cooperative arrangements with universities, colleges and state education agencies for educational research
1958	National Defense Education Act--provided assistance to institutions of higher education and college students
1961	Area Redevelopment Act--included provisions for training or retraining of persons in redevelopment areas
1962	Manpower Development and Training Act--provided training in new and improved skills for the unemployed and underemployed
1963	Health Professions Educational Assistance Act--provided funds to expand teaching facilities and for loans to students in the health professions
	Higher Education Facilities Act--provided for grants and loans to institutions of higher education for classrooms, libraries, and laboratories
1964	Library Services and Construction act--authorized federal assistance in construction of libraries and in provision of library services

1964 (cont.)	Economic Opportunity Act--provided grants for basic adult literacy training and college work-study programs for students of low-income families
	Nurse Training Act--authorized support of construction of facilities, and projects for improvement of instruction, and student loan programs for nurses
1965	Health Professions Educational Assistance Amendments--authorized scholarships to aid needy students in the health professions and grants to improve the quality of teaching in schools of medicine, dentistry, osteopathy, optometry, and podiatry
	Higher Education Act--provided grants for university community service programs, college libraries, developing institutions, scholarships, insured loans, teacher training programs and teaching equipment. Established a National Teacher Corps and provided for graduate teacher training fellowships
	Medical Library Assistance Act--provided assistance for construction and improvement of health sciences libraries
	National Foundation on the Arts and Humanities--authorized grants and loans for projects in the creative and performing arts, and for research training, and scholarly publications in the humanities.

In some cases the statutory pattern of federal purchase and support of academic research coincides with the pattern of support of educational activities, while in other instances the two patterns diverge in significant ways. Chart II sets forth the major congressional acts affecting the funding of academic research by federal agencies.

CHART II

MAJOR CONGRESSIONAL ACTS AFFECTING THE FUNDING OF ACADEMIC RESEARCH BY FEDERAL AGENCIES, TO 1965

Year	Act and Purpose
1862	First Morrill Act--public land grants to the States for the establishment and maintenance of agricultural and mechanical colleges
1887	Hatch Experiment Station Act--established agricultural experiment stations in each state
1906	Adams Act--established continuing federal commitment to support of research at experiment stations
1925	Purnell Act--extended research program to include marketing, rural sociology, agricultural economics and home economics
1935	Bankhead-Jones Act--authorized an annual appropriation of $1 million for experiment station research for five years, and $5 million, thereafter, with emphasis on the economic and sociological aspects of farm problems

1937	National Cancer Institute Act--authorized the National Cancer Institute to make grants for cancer research
1941	First War Powers Act--suspended advertising and other procurement requirements for research contracts
1944	Public Health Service Act--conferred on the Surgeon General of the Public Health Service the power to make grants-in-aid to universities, other institutions, and individuals
1946	Office of Naval Research Act--conferred on the Office of Naval Research the power to make research contracts
	Atomic Energy Act--created the Commission and conferred on it the power to make research contracts
1947	Armed Services Procurement Act--suspended advertising and several other procurement requirements in the case of research contracts made by military agencies
1949	Federal Property and Administrative Services Act--suspended advertising and several other procurement requirements in the case of research contracts made by non-military agencies
1950	National Science Foundation Act--established the Foundation and conferred upon it the power to make grants for research and science education

1954	Executive Order 10521--approved the support by federal agencies other than NSF of basic research in areas closely related to their missions, and provided that NSF should be increasingly responsible for the support of general purpose basic research
	Atomic Energy Act of 1954--provided for industrial participation in the development of atomic power, and provided for agreements for cooperation between the United States and other countries in the development of atomic power
1956	Amendment to Atomic Energy Act of 1954--authorized AEC to make grants for facilities and equipment to universities and related institutions for educational purposes
1958	Science and Technology Act--extended authority to make grants for research to all agencies having authority to enter into research contracts
	National Aeronautics and Space Administration Act--created NASA and conferred upon it the authority to support research for space exploration, aeronautics, and related purposes
1960	National Institutes of Health Institutional Grants Act--authorized NIH grants to nonprofit institutions for the general support of their research and research training programs, not to exceed 15 percent of the amounts provided for grants for research projects for any fiscal year

1963	Health Research Facilities Act--authorized extensive grants for the construction of health research facilities
1965	Higher Education Act--authorized creation by the Office of Education of university-community extension programs for research and service relating to social problems
	State Technical Services Act--authorized creation by the Department of Commerce of programs designed to promote the transfer of technical information from universities to industry

Legal and Administrative Patterns of Funding Academic Research

For purposes of this analysis, four basic types of legal-administrative patterns of funding academic research have been evolved under the statutory grants of authority identified in Chart II: (1) the pattern of a grant-in-aid to a state, exemplified in the Morrill Act of 1887 and subsequent legislation and administrative action; (2) the pattern of contract procurement; (3) the pattern of a grant to or contract with an individual nominally made through the institution at which the individual works, for work on a specifically defined problem; and (4) the pattern of a grant to a university or to a subdivision of a university,

either for a specifically defined purpose related to the conduct of research, or for the general purpose of strengthening the research capability of the university. In the public law of American research these are the four fundamental patterns that have been developed to relate the institutions and powers of the federal government to institutions of higher education for research and related purposes. These patterns are distinguished from each other by the objectives that each pattern is designed to achieve, by the criteria used in the allocation of funds, by the legal and administrative instruments used in each pattern, by the location in each pattern of decision-making authority on the specific research conducted, by the location of accountability for the use of funds in each pattern, and by the type of value attributed to federal research funds in each pattern. Chart III sets forth in schematic form the distinguishing characteristics of each of the four basic patterns, with an identification of major agencies that have used some variation of each pattern in funding academic research.

CHART III

LEGAL AND ADMINISTRATIVE PATTERNS USED IN THE FUNDING OF ACADEMIC RESEARCH BY FEDERAL AGENCIES

1. The Land Grant-State Experiment Station

Objective	To increase on a regional basis the production and distribution of farm products
Criteria used in the allocation of funds	(1) Primarily a statutory formula that provides an equal amount of research funds for each state, supplemented by amounts determined by the size of the rural and farm population of each state (2) Secondarily the merit of proposals submitted by experiment stations to the Department of Agriculture
Legal and administrative instruments	(1) Grants-in-aid to states earmarked for experiment station research on specified projects, with matching fund requirements (2) Negotiation between state experiment stations and the Cooperative State Experiment Station Service, Department of Agriculture
Location of decision-making authority on the specific research conducted	(1) State experiment station scientists and directors, subject to the approval of the Cooperative State Experiment Station Service, and in the case of regional research conducted by more than one station, subject to the approval of regional boards

	(2) In the case of other than Hatch Act project proposals submitted to the Department of Agriculture, advisory panels of scientists appointed by the Department of Agriculture
Location of accountability	State experiment station directors and fiscal officers
Type of value attributed to research funds in this pattern	Instrumental, utilitarian value, with emphasis on the economic value of research as a factor in increasing production, and contributing to economic growth and well-being on a state and regional basis
Agencies using a variation of this pattern	Department of Agriculture, Department of Commerce, Office of Education

2. The Procurement Contract Pattern

Objective	To obtain information of immediate relevance to an agency's mission
Criteria used in the allocation of funds	The demonstrated ability of the contractee to produce the information desired
Legal and administrative instruments	Modified procurement contract entered into through negotiation, rather than through formal competitive bidding under advertising procedures
Location of decision-making authority on the specific research conducted	Agency personnel, generally advised by intramural and extramural science advisors

Location of accountability	Contractee, usually a university as a corporate entity
Type of value attributed to research funds in this pattern	Instrumental, utilitarian value, with emphasis on research as a means to the development of information of immediate relevance to the attainment of a specific governmental end
Agencies using a variation of this pattern	AEC, DOD, HEW, NASA in limited cases

3. The Project Grant Pattern

Objective	(1) For science-oriented agencies, promotion of the development of scientific disciplines or inter-disciplinary areas of inquiry as a value in itself (2) For mission-oriented agencies, promotion of the development of information in areas of inquiry of potential relevance to the agency's mission
Criteria used in the allocation of funds	The merit of the proposed research, the record of the proposant, and in the case of mission-oriented agencies, the potential relevance of the research to the agency's mission
Legal and administrative instruments	Grants and flexible "contracts" with individual faculty members, based on a mix of gift and contract principles

Location of decision-making authority on the specific research conducted	Formal or informal panels of scientists who serve on an advisory basis to evaluate proposals, and agency program personnel, usually with scientific backgrounds
Location of accountability	Primarily in the individual grantee, secondarily in the institution at which the grantee is employed
Type of value attributed to research funds in this pattern	(1) For science-oriented agencies, cultural and potential social values of research as a national investment (2) For mission-oriented agencies, potential utilitarian value of research in the fulfillment of the agency's mission
Agencies using a variation of this pattern	NSF, NIH, NASA, DOD, AEC, others

4. Institutional Support Patterns

Form A: Grants to Institutions for Facilities and for the Training of Students

Objectives	To strengthen the capacities of educational institutions as institutions to perform research and to produce scientific manpower
Criteria used in allocation of funds	Variable: (1) For mission-oriented agencies, the demonstrated ability of institutions to conduct research and to train students on a quality basis

	(2) For science- and education-oriented agencies, the demonstrated potential of institutions to conduct research and to train students on a quality basis
Legal and administrative instruments	Grants to institutions based on prior negotiations
Location of decision-making authority on the specific use of funds	Primarily in agency personnel, as advised by intramural and extramural scientists. The selection of individual students for support is made by the institution
Type of value attributed to research funds in this pattern	Emphasis on educational values of research, particularly on research funds as a means of strengthening institutional research capacity and of producing scientific manpower
Agencies using a variation of this pattern	AEC, NASA, DOD, NSF, NIH

Form B: Grants for Research in a Broad Interdisciplinary Area of Inquiry

Objectives	To promote the development of an interdisciplinary area of inquiry while concurrently strengthening the scientific capability of institutions in that area of inquiry
Criteria used in allocation of funds	Demonstrated potential of an institution to undertake extensive research involving a substantial commitment of personnel and facilities

Legal and administrative instruments	Grants to institutions, usually to the President or to an individual designated by the institution as its representative, such as a departmental chairman
Location of decision-making authority on the specific use of funds	Primarily within the institution itself, often in a board of faculty members and administrators, with emphasis on cooperation with agency personnel on a continuing basis
Accountability	Institutional responsibility, often exercised through a designated faculty member or administrator
Type of value attributed to research funds in this pattern	Stress on long range investment values of research. Emphasis on development of a coherent area of inquiry requiring cooperative effort not readily attainable through grants to individual faculty members, with concurrent emphasis on development of institutional capacity and involvement of institutional personnel in decision-making processes
Agencies using a variation of this pattern	NIH, NASA and to a limited extent NSF and DOD

Form C: Institutional Grants on a Formula Basis

Objective	To provide institutions conducting federal research with "free" funds to be spent on the research needs of the institutions not met through other programs

Criteria used in allocation of funds	A formula resulting in an award, in the form of undesignated funds, of a percentage of the other federal research funds received by an institution
Legal and administrative instruments	Grant to institution for general research purposes
Location of decision-making power on the specific use of funds	The President and Trustees of the institution
Type of value attributed to research funds in this pattern	Increase of institution's control over the direction of its research and satisfaction of its research needs
Agencies using a variation of this pattern	NSF, NIH

Form D: Institutional Grants for Developmental Purposes

Objective	To create new centers of excellence in research and science education
Criteria used in allocation of funds	Demonstrated potential of an institution to develop in one or more science area, with weight given to regional location
Legal and administrative instruments	Grant to institution for developmental purposes specified in a proposal, preceded by extensive negotiations between agency personnel and university administrators and faculty

Location of decision-making power on the specific use of funds	In the President and Trustees of the institution, with stress on faculty participation
Type of value attributed to research funds in this pattern	Development of new centers of excellence in research and science education in the United States for the realization of regional as well as of national economic, social and educational objectives
Agencies using a variation of this pattern	NSF, NIH

Each of these patterns will be examined in turn.

The Land Grant-Experiment Station Pattern

While significant in itself, the pattern of federal support of research and education exemplified in the land-grant college experiment station pattern is of particular importance in assessing the future of agency-university research relationships because this pattern often is suggested as a prototype to be followed by agencies in funding academic research.[1]

Federal grants for research at State Experiment Stations, most of which are located at land-grant colleges,

[1] See, for example, statement of Dr. Frederick Seitz, President, National Academy of Sciences, in House, Committee on Science and Astronautics, Distribution of Federal Research Funds . . . , pp. 349-70.

are part of a general pattern of research, education, and service designed to increase the production and distribution of farm products in the United States. The basic objective of the Experiment Station pattern is economic in character:

> It is important to keep in mind that while our public agricultural research involves both Federal and State action, it is essentially a single program to a single national purpose--the most efficient production, processing, marketing, and distribution of the products of the farms and ranches of this country.[1]

The legal and administrative pattern on which the system is based is the grant-in-aid to the states. The Morrill Act of 1862 obligated funds to the states for the establishment of colleges for agriculture and the mechanic arts,[2] while the Hatch Act of 1887 obligated funds to the states for the establishment of agricultural experiment

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[1] Statement of Dr. Bryson T. Shaw, Administrator Agricultural Research Service, U.S. Department of Agriculture, in U.S. Congress, House, Select Committee on Government Research, Federal Research and Development Programs, Hearings, 88th Cong., 1st Sess., 1963, Part I, p. 205.

[2] For the background and history of land grant colleges and universities, see Henry S. Brunner, U.S. Department of Health, Education, and Welfare, Office of Education, Land Grant Colleges and Universities, 1862-1962 (Washington: U.S. Government Printing Office, 1962); Edward Danforth Eddy, Jr., Colleges for Our Land and Time: The Land Grant Idea in American Education (New York: Harpers Brothers, 1956); Richard D. Axt, The Federal Government and Financing Higher Education (New York: Columbia University Press, 1952); and Alice M. Rivlin, The Role of the Federal Government in Financing Higher Education (Washington: The Brookings Institution, 1961).

stations.[1] The grants made under the Morrill Act were "the prototype of many modern grants-in-aid. They were the first conditional grants of a now very familiar type."[2]

Several states designated a public state university as the land-grant college, while others, particularly states in the East, designated private institutions as the recipients of land grant funds.[3] In most cases the state experiment stations are located at land-grant colleges and universities. Federal grant funds to state experiment stations are administered by the Cooperative State Experiment Station Service of the Department of Agriculture, while federal funds to land-grant colleges for educational purposes are administered by the Office of Education. State experiment personnel frequently teach in the colleges and universities at which the experiment stations are located. In fiscal year

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[1] For a detailed history of state experiment stations, see U.S. Department of Agriculture, Cooperative State Experiment Station Service, State Agricultural Experiment Stations: A History of Research Policy and Procedure (Washington: U.S. Government Printing Office, 1962).

[2] W. Brooke Graves, American Intergovernmental Relations, Their Origins, Historical Development, and Current Status (New York: Charles Scribner's Sons, 1964), p. 496.

[3] The practices followed by various states are described in Henry S. Brunner, U.S. Department of Health, Education, and Welfare, Office of Education, Land-Grant Colleges and Universities, 1862-1962 (Washington: U.S. Government Printing Office, 1962).

1965, for example, of the 10,095 workers engaged in research at all state experiment stations, 5,668 also engaged in teaching.[1] In addition to research and teaching, experiment station personnel also engage in some extension work, although other services of the Agriculture Department also share responsibility for extension work with the Cooperative State Experiment Station Service.

Under the original Hatch Act and subsequent legislation, federal funds are allocated to each state experiment station by a formula that provides an equal amount for each state, supplemented by amounts determined by the size of the rural and farm population in each state. In addition, each station is eligible to receive funds for participation in regional research involving cooperative research by two or more stations. The stations also are eligible to receive funds under the following statutes: (1) the Cooperative Forestry Research Act of October 10, 1962, known as the McIntire-Stennis Act[2] and (2) the Science and Technology Act

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[1] U.S. Department of Agriculture, Cooperative State Research Service, Funds for Research at State Agricultural Experiment Stations and Other State Institutions, 1965 (Washington: U.S. Department of Agriculture, 1966), p. 4.

[2] P.L. 87-788, October 10, 1962, 76 Stat. 806, 16 U.S.C.A. 582a.

of 1958,[1] authorizing all agencies authorized to make contracts to also make grants for basic research.

The stations also receive funds administered by other agencies of the Department of Agriculture than the Cooperative State Research Service, as well as from state governments and non-governmental sources. The states are required by law to match the Hatch Act funds appropriated to the station in the state. The non-federal contributions to the stations generally exceed the federal contributions by about $2 to $1. In fiscal year 1965, the total federal contribution was about $46 million, while the non-federal contribution was about $158 million. Since the amount allocated to each station is determined by formula, each station submits to the Cooperative State Research Service proposals that total the amount allocated to that station. However, when a proposal is submitted it does not set forth a fixed budget, but a statement of general estimated costs. The station can spend funds on almost any type of cost incurred in carrying out approved research, including the costs of equipment, supplies, salaries, utilities, janitorial service, and repair of buildings.

[1] P.L. 85-934, September 6, 1958, 72 Stat. 1793, 42 U.S.C.A. 1891-1893.

The originating station scientist usually submits a proposal in an informal or formal form to the head of the department in the station in which he works, who after consultation with the scientist forwards the proposal to the station director. The director then evaluates the quality of the proposal, usually with the help of a group of other scientists, and determines the availability of facilities and funds to carry out the proposed research. He then submits the proposal to the Cooperative State Research Service for review and approval for funding. Accountability for funds lies in the station directors and the fiscal officers of the stations.

The land grant-experiment station pattern of funding research has several characteristics that distinguish it from other patterns relied upon by other agencies. These characteristics are sometimes claimed to make this pattern a more desirable one than alternative patterns for the systematic funding of academic research by federal agencies.

1. Funds are allocated to states, rather than to private institutions or to individuals. In American public law, there is now a well-established tradition for the grant of funds by one government to another, in this case by the federal government to state governments. The tradition of granting federal funds to private institutions and individuals on a long term, systematic basis for the achievement of a public purpose is less well established and has been a source of concern and criticism based on grounds of inequity and the difficulty of establishing accountability for the use of funds.[1]

2. Funds are allocated on the basis of a formula which minimizes claims that undue political influence is exercised in the allocation of funds, or that one group or region is favored over another in the allocation of funds.

3. Cost sharing by the states is required. This increases the interest in and the commitment of the states to research.

4. The decisions on the research performed are made by scientists at the local level, and each station

[1]For a review of direct federal relations with private institutions and individuals, see Graves, American Intergovernmental Relations, . . . pp. 869-82.

is relatively free to develop in the directions that station scientists consider most desirable. Each station is free to adapt its research to the particular needs of the area in which it is located.

5. Accountability for the use of funds is vested in each station and its fiscal officers, who are public agents. Station directors generally have considerable latitude in the expenditure of funds, which minimizes red tape requirements prevalent in some other funding patterns.

6. Research support in this pattern is fairly stable, a fact that allows stations to recruit scientists, give them tenure, and plan for the development of the station over time.

7. Experiment station research is one phase of a general pattern of research, education, and service designed to increase agricultural productivity. Because it is rationalized in terms of economic development, and has benefited the traditionally strong interest group of farmers, this research pattern has had over time a strong and stable base of political support.

It is frequently pointed out that there are

disadvantages as well as advantages inherent in the land grant-experiment station pattern of funding academic research.[1]

1. Because funds are allocated primarily by formula, the system is only secondarily a merit system, when merit is judged by criteria derived from the internal needs of science itself. This fact contributed to the defeat of the proposal to obligate 25 percent of academic research funds to universities through the use of a land-grant pattern, at the time of the creation of the National Science Foundation.

2. Because funds are dispersed throughout the 50 states, it is sometimes difficult to undertake well-organized research on problems of a national character in this system. For the same reason, it is difficult to build up outstanding "centers of excellence."

Despite these and similar disadvantages, several characteristics of this pattern have repeatedly been suggested for adaptation for the funding of academic research in other contexts. In his Education Message of 1965, President Johnson stated that:

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[1]Some of the disadvantages inherent in this pattern were discussed by Dr. Byron F. Shaw of the Agricultural Research Service in his appearance before the Elliott Committee. See U.S. Congress, House, Select Committee on Government Research, Federal Research and Development Programs, Hearings, 88th Cong., 1st Sess., 1963, Vol. I, pp. 200-217, especially pp. 206-207.

> Institutions of higher learning are being called on ever more frequently for public service. . . . Once, 90 percent of our population earned its living from the land. A wise Congress enacted the Morrill Act of 1862 and the Hatch Act of 1887. . . . Today, 70 percent of our people live in urban communities. . . . The time has come for us to help the university to face problems of the city as it once faced problems of the farm.[1]

A provision for the creation of university-community extension programs was included in the Higher Education Act of 1965.[2] These programs are to be designed to assist in the solution of community problems such as housing, poverty, government, employment, transportation, health, and land use. Congress authorized $25 million for the fiscal year ending June 30, 1966, and $50 million for each of the next two years. Ten million dollars were appropriated for fiscal year 1967. Allotments are to be made on the basis of $100,000 to each of the states, with the remainder allotted on the basis of population. Each state is required to designate or create an agency or institution that is broadly representative of institutions of higher education in the state to formulate a plan for the administration of community service programs

[1] Message to Congress on Education, January 12, 1965, reprinted in Congressional Quarterly, The Federal Role in Education (Washington: Congressional Quarterly Service, 1965), p. 53.

[2] P.L. 89-329, November 8, 1965, 76 Stat. 1219, 20 U.S.C.A. Secs. 403 et seq.

in the universities in the state. While not a pure research program, the University-Community Extension Program represents an initial attempt to apply to metropolitan problems some of the advantages of the land grant-experiment station pattern of research and service.

The State Technical Services Program[1] is another program based in part on the pattern of funding research exemplified in the land grant-experiment station pattern.[2] The basic purpose of the State Technical Service Act of 1965 is to enable the federal government to make grants to states in support of programs to achieve more effective commercial use of the findings of science and technology. The Act requires matching funds from the states. To qualify for federal funds, a state must assign to an institution or agency responsibility for preparing technical service programs within the state, for submission to the Secretary of Commerce for approval. The Act provides that if the institutions or agency designated by a state is not a state

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[1] P.L. 89-182, September 14, 1965, 79 Stat. 107, 15 U.S.C.A. 261-263.

[2] For the background of this program, see U.S. Congress, House, Committee on Interstate and Foreign Commerce, State Technical Services Act of 1965, Hearings before the Subcommittee on Commerce and Finance, 89th Cong., 1st Sess., 1965. For an analysis of how a somewhat similar program has worked in England, see K. Grossfield and J. B. Heath, "The Benefit and Cost of Government Support for Research and Development," Economic Journal, LXXVI, No. 303 (September, 1966), 537.

university or land-grant college, the state shall furnish the Secretary of Commerce a written statement of the reasons for not using the land-grant college or state university. Funds are allocated to the states by a formula based on population, the industrial and economic development of the state, and the technical resources of the state.

The exact formula is to be determined by the Secretary of Commerce, and weighted to provide funds to states and regions where industrial development has lagged and where technical resources are weak. All institutions of higher education with engineering, business, and similar programs are intended to be eligible for participation in the programs established by states under the Act.

> The present plan calls for the institutions that would actually carry out the plan to be generally colleges and universities which offer, as a minimum, a qualified engineering degree or qualified degree in business administration. The purpose of the State agency is to bring together the institutions in the State . . . and decide what each one wishes to do in terms of the industry of the local area of their institution.[1]

Like the Community Service Program established by the Higher Education Act of 1965, the State Technical

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[1] Statement of J. Herbert Hollomon, Assistant Secretary for Science and Technology, Department of Commerce, U.S. Congress, House, Committee on Interstate and Foreign Commerce, State Technical Services Act, 1965, Hearings before the Sub-committee on Comerce and Finance, 89th Cong., 1st Sess., 1965, p. 22.

Services Program is not a pure academic research program in the conventional sense. It is, however, another attempt to apply to current economic and social problems some of the basic principles of research and service exemplified in the land grant-experiment station pattern of funding research and applying research to the satisfaction of regional needs. As is discussed in Chapter V below, these programs may in part relieve some of the pressures that have been exerted on the federal academic research funding system in the 1960's.

The Procurement Contract Pattern

The second major pattern used by agencies to fund academic research is the procurement contract pattern. The use of contracts to fund academic research is part of the legal and administrative phenomenon of "contracting-out" that has materialized since World War II. "Government faced with public expectation that it will expand its functions but not expand its bureaucracy, freely farms out to private organizations staggering proportions of the public business."[1] With a few limited exceptions, until

[1]Harlan Cleveland, "The Blurred Line Between 'Public' and 'Private,'" Ethics and Bigness, ed. Harlan Cleveland and Harold D. Lasswell (New York: Harper and Brothers, 1962), XXV. See also, U.S. Bureau of the Budget, Report to the President on Government Contracting for Research and Development (the Bell Report), Senate Doc. 94, 87th Cong., 2d Sess., 1962, reprinted in U.S. Congress, House, Government Operations Committee, Hearings on Systems Development and Management, 87th Cong., 2d Sess., Part 1, Appendix 1; Arthur S. Miller, "Administration by Contract: A New Concern for the Administrative Lawyer," New York University Law Review, XXXVI (1961), 957; Symposium, "Government Contracts," Law and Contemporary Problems, XXIX, Nos. 1 and 2 (1964); Don K. Price, Government and Science (New York: Oxford University Press, 1962).

World War II the incentives to federal agencies to fund research in universities were limited because research of a fundamental nature was not generally regarded as an efficacious means to immediate governmental ends.[1]

In the early 1900's when industry was beginning to systematically apply science to technology in the pattern that apparently was first established in the German chemical and dye industries, the major universities in the United States were becoming the sites of disinterested, pure research.[2]

A. Hunter Dupree asserts that

> In 1900 the universities, grown in one generation from colleges with narrow courses of studies, seemed to have become the national homes of disinterested, pure science. . . . With Johns Hopkins setting the pace, such universities as Harvard, Cornell, Chicago, Columbia, and Michigan became the headquarters of fundamental research in the country. The result was a division of labor which gave rise

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[1] See A. Hunter Dupree, Science in the Federal Government (Cambridge: Harvard University Press, 1957). See also, Carroll W. Purcell, Jr., "Science and Government Agencies," Science and Society in the United States, ed., David Van Tassell and Michael Hall (Homewood, Ill.: The Dorsey Press, 1966), pp. 223-50.

[2] See D. S. L. Cardwell, "The Development of Scientific Research in Modern Universities," Scientific Change, ed. A. C. Crombie (New York: Basic Books, 1963), p. 671; T. K. Derry and Trevor Williams, A Short History of Technology (New York: Oxford University Press, 1961); Aaron W. Warner, Dean Morse and Alfred S. Eichner (eds.), The Impact of Science on Technology (New York: Columbia University Press, 1965).

> to the assumption that basic research belonged to the universities, leaving only applied research to the government. The difference heightened between the disinterested, cloistered seeker for pure knowledge and the grubby civil servant chained to mundane, grinding routine investigation. Although the split between basic research and the common concerns of society was noticeable fairly early in the nineteenth century, after 1900 it became institutionalized in the division of functions between government and the universities.[1]

Dupree points out that as late as 1936 the Army General Staff recommended the virtual elimination of research of all kinds as an item in the defense budget, on the assumption that the war as then envisioned would not be dominated by technological changes based on scientific research.[2]

For all practical purposes the year 1940 marks the beginning of a new era in the relationship of the federal government to science, particularly to basic science, in the United States. This new era has been marked by the systematic funding of scientific research by governmental agencies in the expectation that research will culminate in information relevant to the attainment

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[1] Dupree, Science in the Federal Government, pp. 296-97.

[2] Ibid., p. 367.

of specific governmental objectives. Underlying this development is the pursuit of science for its potential relevance to the creation of new products and processes. After reviewing the history of the relationship of science to technology, Hendrick W. Bode concluded that

> The deliberate application of science to technology on a broad scale is primarily a phenomenon of the war and post-war years. The change has come about partly because science now has more to offer than it ever had before. It is also due in large part to the fact that the public, principally because of wartime experience, now accepts the idea that science is applicable to technology, and looks to such applications as a mainspring of progress.[1]

A. Hunter Dupree has expressed a similar judgment:

> So far as a line can be drawn across the continuous path of history [1940] separates the first century and a half of American experience in the field from what has come after. . . . By the time the bombs fell on Hiroshima and Nagasaki, the entire country was aware that science was a political, economic, and social force of the first magnitude.[2]

The massive involvement of the federal government with academic research during World War II came about through a variety of ad hoc responses to immediate demands

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[1] Hendrik W. Bode, "Reflections on the Relation Between Science and Technology," in National Academy of Sciences, Basic Research and National Goals (Washington: National Academy of Sciences, 1965), p.74.

[2] Dupree, Science in the Federal Government, p. 369.

and was administered primarily through the use of procurement contracts.[1] From a legal and administrative point of view, the only general precedent for the funding of research in universities prior to 1940 was the agricultural research system. In 1940, the use of the grant as an instrument for funding research, except for agricultural research, was approved by statute for only one agency, the National Cancer Institute.[2] The legal and administrative instruments and procedures used in funding agricultural and cancer research were not regarded as appropriate instruments for the purchase by government of research of immediate relevance to national defense.[3]

Because the government procurement contract is well established in American law,[4] the Office of Scientific

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[1]For the history of federal support of research in universities during World War II, See Stewart, Organizing Scientific Research for War . . . ; James Phenny Baxter, 3d, Scientists Against Time (Boston: Little Brown, 1946); James B. Conant, "The Mobilization of Science for the War Effort," American Scientist, XXXV (April, 1947), 195-210; Richard G. Hewlett and Oscar E. Anderson, The New World, 1939-1946 (University Park: Pennsylvania University Press, 1962).

[2]National Cancer Institute Act, 50 Stat., 559 (August 5, 1937).

[3]Stewart, Organizing Scientific Research for War.

[4]See Edwin P. Bledsoe and Harry I. Ravitz, "The Evolution of Research and Development as a Procurement Function of the Federal Government," Federal Bar Journal, XVIII, No. 3 (1957), 189.

Research and Development decided to use a variation of the procurement contract to buy research from universities. The contracts used paid the full costs of the research, but did not pay a profit.

Prior to World War II, government contracts in most cases were awarded on the basis of formal advertising.[1] The First War Powers Act suspended advertising and other procurement requirements for research contracts, and authorized negotiation of such contracts.[2] This Act was relied upon in the creation of federally sponsored central research laboratories at Massachusetts Institute of Technology, California Institute of Technology, the University of Illinois, and other universities, and in the procurement of research services from individual scientists and groups of scientists in universities throughout the country.

In 1945, the War Production Board proposed that legislation be enacted to replace the First War Powers Act. The final result was the Armed Services Procurement Act of 1948.[3] The Act exempts research and development

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[1] Rev. Stat., 3709, as amended, 41 U.S.C.A. 5.

[2] 55 Stat., 838 (1941).

[3] 62 Stat., 21C (1948), as amended, 10 U.S.C.A. 2301 et seq. (1958).

contracts from advertising requirements, and specifically authorizes the negotiation of contracts with universities.[1] The basic principles exemplified in the Act and regulations based on it, as these principles relate to research and development, have been expressed by Albert C. Lazure in his capacity as General Counsel of the Chief of Ordnance, Department of the Army, as follows:

> A research and development contract is a written memorandum evidencing a mutual agreement between two parties, the contractor and the Government, both of whom, at the time of negotiation of the contract, are free parties.
>
> Under the contract, once negotiated, the contractor promises to set to work on specified problems, or in specified fields, the brainpower, the scientific and engineering knowledge, and the highly developed research or development techniques of certain scientists and engineers in order to accomplish the results desired by the Government. . . .
>
> In effect, what the Government is buying is competence of individuals and organizations in the fields in which it reasonably may be expected that the solution will be obtained. What is to be supplied is not an "on the shelf" item, nor is it listed in a catalogue.
>
> It follows, therefore, that a sound appraisal of the competence of the individuals and organizations that will do the work is the most critical determination required by those responsible for the procurement of research and development, an appraisal which is different from that required for the procurement of material.[2]

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[1] 10 U.S.C.A. 2304(a), 5, 11.

[2] Albert C. Lazure, "Why Research and Development Contracts are Distinctive," XVII, Federal Bar Journal (July-September, 1957), 260-61.

The Armed Services Procurement Act and the massive regulations promulgated under the Act apply to the Army, Navy, Air Force, Coast Guard, and NASA.[1]

The general research and development policy statement set forth in Armed Service Procurement Regulation 4-202 expresses, from a legal viewpoint, the basic rationale underlying research and development contracts:

> A fundamental mission of research and development programs is to maintain scientific and technological superiority requisite to promote and advance the effectiveness of military operations. The accomplishment of this mission requires the broadest possible base of contractor and subcontractor sources including the optimum use of manpower and resources. It is essential that the best technical competence be located and fully utilized. The procurement pattern of research and development must be responsive to the achievement of these goals on a timely basis.[2]

A number of the Armed Services Procurement

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[1]The Armed Services Procurement Regulations are published in the Federal Register, as required by Sec. 3 of the Administrative Procedure Act, 5 U.S.C.A. 1002, and compiled in Title 32 of the Code of Federal Regulations. For an analysis of the relevance of the Armed Services Procurement Regulations to research and development contracts, see U.S. Congress, House, Select Committee on Government Research, Contract Policies and Procedures for Research and Development, Report, 88th Cong., 2d Sess., 1964.

[2]Armed Services Procurement Regulation, Part IV, Sec. 202 (November 1, 1964).

Regulations apply to contracts with educational institutions, including regulations pertaining to standards of work, assignment of claims, nondiscrimination in employment, patent rights, military security requirements, insurance liability to third persons, auditing and record keeping, and similar matters.[1]

While only the Army, Navy, Air Force, Coast Guard and NASA are subject to these provisions, similar provisions are applicable to contracts made by other agencies under the procurement regulation system promulgated by the General Services Administration under Title II of the Federal Property and Administrative Services Act.[2]

The inappropriateness of applying procurement provisions to contracts with universities for basic research has been recognized since the 1940's.[3] By definition, a contract is a promise or a set of promises for the breach of which the law gives a remedy, or the performance of which the law recognizes as a duty. Because of the

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[1]For an analysis of the application of these regulations to agency-university contracts, see Leroy Kahn, "The Lawyer and the Scientific Community-Procuring Basic Research," Law and Contemporary Problems, XXIX (1964), 631.

[2]40 U.S.C.A. 486(c).

[3]See Vannevar Bush, Science--The Endless Frontier (Washington: U.S. Government Printing Office, 1945), reprinted by the National Science Foundation, 1960, p. 39.

unpredictable course research often takes,[1] it is very difficult to describe the contractor's obligated performance except in a general way. Conversely, it is difficult, if not impossible, to determine whether there has been a breach of the contract, except in regard to specific provisions such as provisions specifying the purposes for which funds can be spent under the contract. In addition, the detailed reporting and auditing provisions usually required in procurement contracts are considered an unnecessary burden on investigators in an academic environment, both because such provisions frequently take up time that could better be spent on substantative research, and because such provisions often do not realistically apply to research performed in a context of free inquiry.

Finally, from a psychological point of view, the imposition of detailed requirements on the research process may stifle freedom of inquiry in the process and thus inhibit the originality of the investigation.

For this and other reasons, the National Science Foundation proposed in 1958 that all agencies authorized

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[1] See, e.g., William J. B. Beveridge, The Art of Scientific Investigation (New York: Random House, 1957); R. Taton, Reason and Chance in Scientific Discovery (New York: Science Editions, 1962).

to make contracts for basic research also be authorized to make grants for the support of basic research. In the hearings on the proposal, the director of the Foundation outlined the advantages of the grant over the contract, as seen by the Foundation:

> First, the psychological relationship between the recipient institution of individual and the Government is more in keeping with the concept of maximum freedom of action for the scientific investigator. Second, the problem is avoided of endeavoring to adapt detailed contract regulations designed primarily for the procurement of hardware to the support of creative, fundamental research. Third, advance payment of the grant can be made without the vouchering of expenditures and accompanying "progress reports" or other "proof of work," both of which exercise a deadening effect upon the initiative of the scientist.[1]

The Foundation's proposal became Public Law 85-934.[2] In its report recommending passage of the law, the Senate Committee on Government Operations stated that the basic purpose of the law is to simplify the administration of basic research programs by removing basic research programs

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[1] Statement of Dr. Alan T. Waterman, Director of the National Science Foundation, in U.S. Congress, Senate, Committee on Government Operations, Science and Technology Act of 1958, Hearings, 85th Cong., 2d Sess., 1958, Part 2, p. 301.

[2] 2-72 Stat. 1793, 42 U.S.C.A. 1891-1893.

from the requirements of the Armed Services Procurement Regulations.[1]

As originally conceived, Public Law 85-934 seemed to constitute a recognition by Congress of the difference between federal purchase of research and federal support of research. The purchasing or procurement pattern usually is characterized by: (1) initiation of the research idea in the agency itself; (2) retention within the agency of decision-making authority on the exact research undertaken; (3) fairly close supervision by the agency of the work performed; (4) fairly stringent auditing and accounting requirements; and (5) payment after performance of the work. In contrast, the project grant pattern usually is characterized by (1) initiation of the research idea by the researcher, and the submission of a verbal or written proposal to an agency; (2) location of decision-making authority on the question of whether the research is worthwhile in a board of scientists, usually subject to agency review; (3) little or no supervision by the agency of the work performed; (4) liberal reporting, accounting, and auditing

[1] U.S. Congress, Senate, Committee on Government Operations, Science and Technology Act, Report, 85th Cong., 2d Sess., 1958. See also, J. W. Whelan, "Public Law 85-934--New Federal Support for Basic Research," Journal of Public Law, VIII (1959), 462.

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instead of contracts. The agency concluded that the quid pro quo concept that is at the heart of a contract is more suitable for work funded by a mission agency than the concepts that underlie a grant. The agency also concluded that in fact if not in theory many grants by federal agencies are administered very much like contracts.[1]

The second reason that a government-wide recognition of the difference between grants and contracts has not emerged is that appropriations subcommittees have consistently refused to permit the full payment of indirect costs under grants, while such costs usually are fully paid under contracts.[2] Whatever the merits of this policy, its practical effect has been to make research contracts rather than grants more attractive to university administrators.

Finally, a clear recognition of the difference between contracts and grants has failed to emerge because in many instances procurement reporting requirements have

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[1] See the statement of Gerald F. Tape, Commissioner, Atomic Energy Commission, in House Committee on Science and Astronautics, Distribution of Federal Research Funds . . . , p. 172.

[2] For a background analysis of this issue, see U.S. Congress, House, Committee on Science and Astronautics, Indirect Costs Under Federal Research Grants, Report of the Subcommittee on Science, Research, and Development, 88th Cong., 2d Sess., 1964.

been superimposed on grant relationships. Contracts are well established in the American legal tradition. In contrast, grants to individuals and to private institutions are not.[1] In the face of congressional and other criticism, agencies have tended to impose well-established reporting and auditing and other requirements on grant relationships in order to protect themselves and grantees from criticism. This has been particularly true in the case of grants made by the National Institutes of Health, but it has also been true for other agencies. The Elliott Committee concluded in 1964 that the advantage of the grant over the contract

> . . . appears to have been drowned in a morass of administrative detail. If it cannot be rescued and the grant restored to its intended function as a valuable research tool, the fiction of difference between grants and contracts should be obviated, and the grant eliminated, to be replaced openly and unequivocally by the contract. It seems appropriate to recall again the mandate laid down by the Congress in Public Law 85-934 . . . and to call for restoration of the grant to its intended function--to "stimulate and support fundamental research."[2]

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[1] See Graves, American Intergovernmental Relations, Part VI: "Direct Federal Relations with Institutions," p. 864, and "Direct Federal Relations with Individuals," p. 869.

[2] U.S. Congress, House, Select Committee on Government Research, Administration of Research and Development Grants, 88th Cong., 2d Sess., 1964, p. 64.

Many other commentators have reached similar conclusions.[1]

Although the differences between grants and contracts have in many cases been obscured by agency practices, fundamental differences between the procurement pattern and project pattern of funding academic research remain, particularly differences in the assignment of decision-making authority over the actual research funded, and differences in the flexibility in the conduct of research.

The Project System

The project system is generally regarded as an administrative innovation of major importance in the funding of academic research by federal agencies, and is credited by many scientists as the primary means by which the freedom of scientists performing research paid for by federal funds has been protected from political domination. Donald Hornig, for example, has stated: "I consider this a major invention in the government support of science and one that is in no small measure responsible for the great success we have had."[2]

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[1] See, e.g., Bureau of the Budget, The Administration of Government Supported Research at Universities (Washington: Executive Office of the President, 1966), especially pp. 18-23.

[2] Donald Hornig, "A Look Ahead," in National Academy of Sciences, Science, Government, and the Universities (Seattle: University of Washington Press, 1966), pp. 10-11.

In a similar vein, the Committee on Science and Public Policy of the National Academy of National Academy of Sciences concluded from its review of government-university research relationships that

> The commitment of large public funds for the support of basic research in universities had led not only to spectacular growth of the scope of scientific effort but also to advances in quality. . . . We attribute this in no small measure to enlightened policies of several federal agencies committed to furtherance of basic research; specifically to the current emphasis on support by research project grants and by fixed-price research contracts (not too unlike grants), coupled with an extensive use of advisory scientific bodies, such as panels or study sections, to select scientifically meritorious projects for support.[1]

The essence of the project system is the funding by an agency of a proposal for work on a defined topic submitted by individual investigators, after an evaluation of the scientific merit of the proposal made by a group

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[1]National Academy of Sciences, Federal Support of Basic Research in Institutions of Higher Learning (Washington: National Academy of Sciences, National Research Council, 1964).

of scientists.[1]

The project system evolved out of the experience of federal agencies in funding academic research in World War II and the following decade. Under the direction of Vannevar Bush, the Office of Scientific Research and Development, in response to a request by President Roosevelt, issued in 1945 what has become the classic statement of the rationale underlying government support of basic science, Science--The Endless Frontier.[2] The report asserted that

> Basic research leads to new knowledge. It provides scientific capital. It creates the fund from which the practical applications of knowledge must be drawn. New

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[1] Both the Elliott Committee and the Committee on Science and Public Policy of the National Academy of Sciences have reviewed the basic characteristics of the project system. The review by the Committee on Science and Public Policy is basically an historical review. See U.S. Congress, House, Select Committee on Government Research, Administration of Research and Development Grants, 88th Cong., 2d Sess., 1964, and National Academy of Sciences, Federal Support of Basic Research in Institutions of Higher Learning. See also, the discussion of the project system in Charles V. Kidd, "Terms and Conditions," American Universities and Federal Research (Cambridge: Harvard University Press, 1959), Chap. 6, pp. 103-22, and Harold Orlans, "The Project System," The Effects of Federal Programs on Higher Education (Washington: The Brookings Institution, 1962), Chap. 18, pp. 250-79.

[2] Bush, Science--The Endless Frontier, reprinted by the National Science Foundation, 1960.

> products and new processes do not appear full-grown. They are founded on new principles and new conceptions which in turn are painstakingly developed by research in the purest realms of science. Today, it is truer than ever that basic research is the pacemaker of technological progress.[1]

The report noted that in the past the United States had relied on Europe as a source of basic discoveries that were often applied through "Yankee ingenuity."

> In the past we have devoted much of our best efforts to the application of such knowledge which has been discovered abroad. In the future we must pay increased attention to discovering this knowledge for ourselves particularly since the scientific applications of the future will be more than ever dependent upon such basic knowledge. New impetus must be given to research in our country. Such new impetus can come properly only from the Government.[2]

Finally, the Report stressed that basic research is best performed in an academic environment.

> Basic research is essentially noncommercial in nature. It will not receive the attention it requires if left to industry. For many years the Government has wisely supported research in the agricultural colleges and the benefits have been great. The time has come when such support should be extended to other fields.[3]

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[1] Ibid., p. 19.

[2] Ibid., p. 12.

[3] Ibid., p. 22.

In the five years that elapsed between the publication of Science--The Endless Frontier in 1945, and the creation of the National Science Foundation in 1950, the Office of Naval Research, and the National Institutes of Health laid the foundations of the project system.[1] Following World War II, many scientists were concerned with the problem of securing federal support of research without subjecting science to political domination.[2] While this and related issues were being debated in connection with the creation of the National Science Foundation and the problem of its organizational structure, the Office of Naval Research and the National Institutes of Health without fanfare began to fund proposals submitted by individual scientists. The Office of Naval Research used informal groups of scientists to evaluate the merits of the proposals, while NIH used groups formally appointed for that purpose. The National Science Foundation immediately adopted this method of funding academic research to its needs following its creation in 1950. In the 1950's and

[1] For a history of this development, see National Academy of Sciences, Federal Support of Basic Research in Institutions of Higher Learning, Part III, "The Government-University Alliance, 1945-50," pp. 35-44.

[2] See, for example, Price, "Freedom or Responsibility," Government and Science.

1960's all of the major research funding agencies have relied heavily on some variation of the project system to fund academic research, particularly basic research. While practices vary from agency to agency, the basic characteristics of the project system can be summarized in terms of the initiation of projects, the evaluation of proposals, and the review of project work.[1]

Projects are initiated by individuals or small groups of individuals in three ways: the unsolicited proposal, the negotiated but unsolicited proposal, and the solicited proposal. The Elliott Committee found that the great majority of research project proposals were unsolicited. In many cases the individual investigator who is aware of the interest of an agency in supporting research in his field submits a proposal without an invitation from the agency. In other cases, the agency stimulates proposals in a given subject area through conferences with potential applicants and the issuance of publications outlining immediate research interests of the agency. Thus, NIH told the Elliott

[1]This is basically the method of analyzing the project system used by the Elliott Committee. See U.S. Congress, House, Select Committee on Government Research, Administration of Research and Development Grants, 88th Cong., 2d Sess., 1964.

Committee that

> . . . in certain priority research fields of particular national importance, indications of particular NIH interest are communicated to the research community through attendance by NIH staff at scientific meetings, through visits by NIH staff to research institutions, and through non-Federal visits by NIH study sections who represent a cross-section of the outstanding scientists in the fields of interest to NIH.[1]

The second way projects are initiated is through negotiation of unsolicited proposals. In this method, informal discussion between the potential applicant and an agency official precedes the formal submission of a proposal. NASA explained this mode of initiating projects to the Elliott Committee as follows:

> Letters and technical discussions often permit the establishment of the community of interest prior to the submission of a formal proposal. It has been found, however, that the interests of all parties are best served if suggestions for the specific research projects are left to the initiative of the proposers.[2]

The third method of initiating projects, direct solicitation of proposals by the agency, is used by most agencies when they are interested in the immediate

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[1] Ibid., p. 9.

[2] Ibid., p. 8.

satisfaction of well-defined needs and are anxious to make certain of the capability of the grantee or contractee. In these instances the project method becomes virtually indistinguishable from the procurement method, even in cases where the formal legal instrument used to fund the research is a grant. However, in most instances of this kind the research is funded through a contract.

In its valuation of the methods of initiating proposals, the Elliott Committee pointed out the fortuitous aspects of reliance on conferences and negotiations to stimulate proposals, and stated:

> In order that all competent people in a given field may have the opportunity to contribute their ideas, the committee commands the practice of open and widespread publication of department and agency research interests. . . . Grant opportunities should not be dependent on merely fortuitous contact with specific Government employees at specific times.[1]

As is noted below, it is often alleged that the project system maximizes the importance in obtaining federal research funds or personal contacts with and participation in the network of science advisory groups

[1] Ibid., p. 10.

that often participate in the decisions on who actually receives research funds. In this respect the project system seems well suited to the operation of "invisible colleges" of prestigious scientists who influence the direction of research in their fields through informal networks of communication.[1]

Two different methods are used to evaluate proposals, evaluation by advisory panels of outside experts and evaluation by agency staffs. NSF, NIH and the Air Force make extensive, systematic use of outside panels. The other agencies generally rely on in-house review, although outside experts frequently are consulted on the general direction of research programs and sometimes on the merits of specific proposals. NSF explained its use of panels to the Elliott Committee as follows:

> A basic research proposal which is submitted to the Foundation for possible support may be reviewed and evaluated scientifically in several different ways. It may be submitted for review to an assembled advisory panel selected for outstanding competence in the particular field involved. . . . It may be sent by mail to scientists throughout the scientific community who are not members of

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[1] See Derek J. de Solla Price, "Invisible Colleges and the Affluent Scientific Commuter," Little Science, Big Science (New York: Columbia University Press, 1963), Chap. 3, pp. 62-91. See also, Warren O. Hagstrom, The Scientific Community (New York: Basic Books, 1965).

> the advisory panel but are expert in the discipline involved. The proposal may result in a site visit to the principal investigator and his institution by members of the professional staff of the Foundation. And . . . the proposal receives a careful review from the professional staff member . . . in the Foundation to whom it has been assigned.[1]

It should be stressed that there is considerable variation from agency to agency in how panels are used.

In-house review of proposals also varies from agency to agency. In-house review usually entails a review of the scientific merits of a proposal at the first level of staff review, and a review of the relevance of the proposed research to the agencies' mission and of the budget of the proposal at the second level.

In general, the criteria used by all agencies, both by those using review by outside panels and those using review by in-house staff include: (1) the scientific merit of the proposal, (2) the qualifications of the principal investigator, (3) the resources of the institution at which the research is to be conducted, (4) where relevant, the relationship of the proposed research to the agency's mission, and (5) the cost of the proposed research.

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[1] Ibid., p. 14.

The maximum period of the grants awarded by the major agencies is NASA--3 years, NIH--7 years, NSF--5 years, and DOD--generally 5 years. The Atomic Energy Commission, which does not use grants, generally uses contracts for a term of one year, with a provision for renewal on an annual basis. In special cases, however, AEC does enter into contracts for a term longer than one year.

All agencies use two basic methods in reviewing projects, site visitations on a selected basis, and written reports. As in the initiation and in the evaluation of proposals, practices vary considerably from agency to agency. The National Science Foundation generally relies on semiannual reports for all grants, coupled with site visitations for all large grants, and site visitations on a sample basis for small grants. The Foundation requires annual fiscal reports for all grants, and audits these reports on a sample basis. The Foundation generally does not attempt, in any formal way, to evaluate the results of a project at the end of a grant period. The

Foundation generally relies on reports of articles published in scientific journals and informal discussions to evaluate the over-all performance under a specific grant. It does not require the submission of a formal product at the end of the grant period.

NIH requires the submission of annual progress reports and of annual fiscal reports in the course of the grant period, and the submission of a final technical and fiscal report at the end of the grant period. A final financial accounting is required which is subject to review by the General Accounting Office. The other agencies also require the submission of a semiannual or an annual technical report, the submission of an annual financial report, and the submission of a final report at the end of the grant period. DOD and NASA financial reports are subject to review by DOD auditors.

While no government-wide data are available on the exact purpose for which project funds are spent by the recipients of the funds, Table 23 sets forth estimates for the National Science Foundation for specified years. As

TABLE 23

ESTIMATED PERCENTAGES OF DIRECT EXPENDITURES OF NATIONAL SCIENCE FOUNDATION PROJECT GRANT FUNDS, SELECTED YEARS, 1954-1966

	1954	1956	1958	1960	1962	1964	1966
Salaries	74.6	73.0	67.1	63.7	63.2	64.2	65.5
Equipment	17.1	17.8	23.1	23.2	24.4	23.8	22.6
Travel and other	8.3	9.2	9.8	13.1	12.4	11.9	11.9

Basic source: U.S. Congress, House, Committee on Science and Astronautics, The National Science Foundation, A General Review of Its First 15 Years, 89th Cong., 1st Sess., 1965, Table 6, p. 46.

Table 24 indicates, the largest percentage of funds is spent on salaries of principal investigators, research associates, research assistants (generally graduate students), and laboratory technicians and other laborers. In recent years salaries have accounted for around 64 percent of expenditures, equipment for around 24 percent, and travel and other costs about 13 percent.

No government-wide data are available on the number of graduate students who are supported by funds awarded for project grants. However, from the returns received from a questionnaire sent to some 2,100 colleges and universities

TABLE 24

SALARY DISTRIBUTION OF NATIONAL SCIENCE FOUNDATION PROJECT GRANT FUNDS, SELECTED YEARS, 1954-1966

	1954	1956	1958	1960	1962	1964	1966
Principal Investigator	19.1	17.6	19.0	N.A.	21.3	21.3	21.0
Research Associate	22.7	27.6	27.7	N.A.	23.2	22.9	23.0
Research Assistant	43.8	32.4	30.8	N.A.	30.7	33.8	34.0
Other	14.4	22.3	22.6	N.A.	24.8	22.0	22.0

Basic source: U.S. Congress, House, Committee on Science and Astronautics, The National Science Foundation, A General Review of Its First 15 Years, 89th Cong., 1st Sess., 1965, Table 6, p. 46.

in the United States, the Elliott Committee concluded that in fiscal year 1963 about 31,877 graduate students were paid $43 million of project funds. These 31,877 students constituted about 14 percent of a total of 232,288 university and college students who received some type of federal support in 1963, excluding veterans' assistance and military training. The $43 million received by students from project funds constituted about 18 percent of the approximately $225 million received by all students from federal sources,

excluding veterans' assistance and military training.

While it is not possible to break down the project funds received by universities and colleges by discipline on a government-wide basis, Table 25 sets forth federal obligations for basic research by detailed field of science for fiscal years 1964, 1965 and 1966. These figures constitute as close an estimate of the distribution of project funds among the fields of science as is presently available. The physical sciences receive about 65 percent of the funds, the life sciences about 29 percent, the psychological sciences about 3 percent, and the social sciences about 2 percent.

While the specific administrative practices followed in the project system vary from agency to agency, and often from division to division within any one agency, a specific example of the administrative practices followed in one division of one agency can be used to illustrate the fundamental practices relied upon in the system. The Division of Social Sciences of the National Science Foundation will be used here as one example of how the system works in one

TABLE 25

FEDERAL OBLIGATIONS FOR BASIC RESEARCH BY DETAILED FIELDS OF SCIENCE,
FISCAL YEARS 1964, 1965 AND 1966
(millions of dollars)

Field of Science	Actual 1964		Estimates 1965		1966	
	$	% of Total	$	% of Total	$	% of Total
Total, All Fields	1,573.9	100.0	1,807.9	100.0	2,049.5	100.0
Total, Life Sciences	441.0	28.0	517.9	28.6	586.4	28.6
Biological Sciences	143.0	9.1	182.3	10.1	220.1	10.7
Medical Sciences	273.6	17.4	302.4	16.7	331.1	16.2
Agricultural Sciences	24.5	1.6	33.2	1.8	35.3	1.7
Psychological Sciences	47.2	3.0	58.4	3.2	69.7	3.4
Total, Physical Sciences	1,049.9	66.7	1,184.1	65.5	1,331.0	64.9
Total, Physical Sciences Proper	862.1	54.8	975.5	54.0	1,105.1	53.9
Astronomy	168.5	10.7	158.8	8.8	187.8	9.2
Chemistry	92.8	5.9	99.1	5.5	111.0	5.4
Earth Sciences						
Atmospheric Science	120.0	7.6	145.4	8.0	176.6	8.6
Oceanography	23.0	1.5	27.4	1.5	32.6	1.6
Solid Earth Sciences	167.3	10.6	211.8	11.7	225.6	11.0
Physics						
Elementary Particle Physics	137.3	8.7	160.0	8.9	179.1	8.7
Nuclear Structure Physics	37.7	2.4	39.1	2.2	45.2	2.2

TABLE 25--Continued

Field of Science	Actual 1964		Estimates 1965		Estimates 1966	
	$	% of Total	$	% of Total	$	% of Total
Atomic, Molecular, and Solid-state	59.8	3.8	69.0	3.8	75.6	3.7
Other Physics	38.1	2.4	40.5	2.2	46.1	2.2
Other Physical Sciences Proper	17.8	1.1	24.8	1.4	25.5	1.2
Mathematical Sciences	52.9	3.4	58.2	3.2	65.4	3.2
Engineering Sciences	134.9	8.6	150.3	8.3	160.5	7.8
Total Social Sciences	34.2	2.2	40.1	2.2	52.8	2.6
Anthropology	7.2	a	7.8	a	11.1	a
Economics	10.8	a	12.1	a	14.6	a
Sociology	5.4	a	6.2	a	7.8	a
Other Social Sciences	10.8	a	14.1	a	19.2	a
Other Sciences	1.5	a	7.4	a	9.7	a

Basic source: National Science Foundation, Federal Funds for Research, Development, and Other Scientific Activities, Fiscal Years 1964, 1965, 1966, Vol. XIV (Washington: U.S. Government Printing Office, 1965), Table C-17, p. 106.

[a]Less than 1 percent.

division of one agency. Organizationally, the Division of Social Sciences of the National Science Foundation is one of the five research divisions of the Foundation. The Social Science Division has programs in anthropology, economics, the history and philosophy of science, political science, geography, sociology and social psychology, and special projects. Because NSF's basic objective in supporting research is to develop scientific knowledge as an end in itself, rather than as a means to achievement of a mission objective, Foundation officials take the position that there is no abstract standard by which they can determine whether the level of support of a given discipline is or would be appropriate.[1]

Given a policy of equal receptivity to proposals from all fields capable of doing scientific research, the Foundation's method of allocating funds among various fields is described by Director Leland J. Haworth as "largely a self-governing mechanism."[2] This self-governing mechanism influences the Foundation's allocation of research

[1] See the statement of Leland J. Haworth, Director, National Science Foundation, in House Committee on Science and Astronautics, Review of the National Science Foundation . . . , Part I, pp. 763-91.

[2] Ibid., Vol. I, p. 785.

funds among the major science areas--physical, biological and medical, and social--and the allocation of funds to specific sciences within each major science area. This self-governing mechanism as it operates in the Division of Social Sciences can be analyzed in terms of the relationships among the inputs, internal processes, outputs, and feedbacks of the process. In summary form, the amount of money allocated by the Division of Social Sciences to a particular program is influenced by three characteristics of the demands made on the system in the form or proposals: (1) the dollar value of proposals from each field, (2) the absolute number of proposals from each field, and (3) the "quality" of proposals from each field. The "quality" of the proposals is measured by the extent to which the proposals meet the formal and informal criteria by which proposals are evaluated. The formal criteria[1] are the scientific soundness of the proposals, and the predictability that the proposed research will result in a significant advancement of knowledge in the field. The informal criterion is the reputation of the proposant in

[1]For a statement of the formal criteria used by the Foundation, see House Committee on Government Operations, Conflicts Between the Federal Research Program and the Nation's Goals for Higher Education . . . , p. 59.

his field.[1]

The dollar volume, number, and quality of proposals from a particular field, in turn, are influenced by the organization and internal processes of the Division, and by the outputs fashioned by these processes. Three internal factors are particularly important: (1) the activities of a Program Director, who usually is a researcher recruited from his field, and is on a leave of absence from a university for a one- or two-year period; (2) the activities of members of an Advisory Panel recruited from the field, who serve on a part-time advisory basis; and (3) the budgetary judgments of the Director of the Social Science Division.

The Program Directors perceive themselves as performing two roles: (1) representing the members of their fields within the Foundation, and (2) representing the Foundation to the members of their fields. The Program Directors represent the members of their fields within the Foundation by participating in the budgetary negotiations that determine how much money is allocated to each Program,

[1] It is often argued that agencies should, and in fact do, support the man rather than the project. See, for example, Kidd, American Universities and Federal Research, pp. 106-108.

by advising the Division Director about special needs of their fields, and by working with the Advisory Panels for their fields. The Program Directors represent the Foundation to members of their fields by visiting universities and attending conferences, and advising prospective applicants about NSF programs and opportunities for support. Each of the Program Directors is available, on request, for consultation with prospective applicants about the form of proposals, the criteria used in proposal evaluation, and similar matters.

The activities of the members of the Advisory Panels are the second factor of importance in the processes within the Division that shape the outputs of the system. The members of the Advisory Panels are selected by the Program Director with the approval of the Division Director, from established researchers in the field. Some attempt is made to achieve comprehensive institutional, geographical, and interdisciplinary representation on the panels, but no rigid formula is used for this purpose. The members of the Advisory Panels play two roles: (1) they evaluate proposals

on the basis of the criteria stipulated by the Foundation, and their knowledge of the standards and needs of their fields, and (2) they serve as conduits for the transmission of information to and from the Program Directors and researchers in their fields.

Finally, the Director of the Social Science Division exercises final judgment in the allocation of funds among the Programs. He has final responsibility for ascertaining that the standards used in evaluating proposals are roughly comparable in all Programs.

The Program Director, the Advisory Panel members, and the Division Director fashion the two basic outputs of the system, the research awards approved by the Panels, and the information and advice about NSF programs and standards that are communicated to the fields by the Program Directors and Advisory Panel members. In turn, the outputs generate interest and knowledge in the fields, that are fed back into the system in the form of research proposals.

In formal terms, grants are made to the universities and colleges at which individual applicants are located.

Grant funds are paid to universities and colleges for work by specified researchers on defined topics. However, responsibility for the expenditure of funds rests primarily with individual grantees.

The Social Science Division does not require the submission of a final product from the sponsored research, but like the other divisions of the Foundation it does require the submission of a report detailing the expenditures of grant funds.

In summary, the operation of the Social Science Division exemplifies the basic principles of the project system: the funding of specific research proposals submitted by individual researchers, reliance on scientific advisors to evaluate the scientific merits of proposals and, in general, reliance on individual researchers for accounting for expenditures of grant funds.

It is now necessary to consider forms of support that have been developed as supplements to the project system, forms of institutional support.

Institutional Support Patterns

Grants to institutions constitute the fourth basic type of legal and administrative patterns used by major agencies to fund academic research and related activities. These grants have taken two basic forms: (1) grants earmarked for detailed, specific purposes, such as grants for the purchase or construction of equipment and facilities, or for the support of the training of students, and (2) grants of funds to institutions with some option on the specific use of funds left, within definite guidelines, to the institution or a department of the institution.

The varieties of these types of grants will be explained through an analysis of the grants made by NSF, NIH, and NASA. The grants made by these agencies illustrate the basic types of grants of an institutional nature made by all federal agencies.

The National Science Foundation

The National Science Foundation classifies the distribution of its funds in six broad categories:

(1) basic research and supporting facilities; (2) science education programs; (3) institutional science programs; (4) science information services; (5) studies of national resources for science and technology; and (6) program development and management.[1]

Table 26 sets forth the budget estimates for each of these categories for fiscal years 1965, 1966 and 1967, while Table 27 sets forth the percentage distribution among the categories. As these tables indicate, the Foundation in fiscal year 1965 allocated about $209 million of its budget, or about 50 percent, to basic research and supporting facilities. Of this $209 million, about $120 million, or 29 percent of the Foundation's total budget, were allocated to basic research project grants. About $60 million, or 15 percent of the Foundation's total budget, were allocated to institutional grants. Before examining the background and nature of the institutional grants it should be pointed out that the Foundation in determining the purposes for which funds are spent classifies funds in three categories: (1) primarily for basic research;

[1] See U.S. Congress, House, Committee on Appropriations, Independent Offices Appropriations for 1967, Hearings, 89th Cong., 2d Sess., 1966, p. 107 (hereafter cited as House Committee on Appropriations, Independent Offices Appropriations . . .).

TABLE 26

SUMMARY OF NATIONAL SCIENCE FOUNDATION BUDGET ESTIMATES BY PERFORMANCE CATEGORY, FISCAL YEARS 1965, 1966, AND 1967
(in thousands of dollars)

Category	Actual FY 1965	Estimate FY 1966	Estimate FY 1967
Basic research and supporting facilities	208,887	247,400	277,200
Basic research project grants	119,471	160,000	185,000
National Research programs	42,194	37,300	33,300
Specialized research facilities and equipment	27,742	27,600	30,000
National research centers	19,480	22,500	28,900
Science education programs	120,415	126,000	140,000
Institutional science programs	60,237	86,100	79,500
Institutional grants for science	11,418	14,500	14,500
Graduate science facilities	21,425	31,600	20,000
Science development program	27,394	40,000	45,000
Science Information services	11,123	13,325	11,400
Studies of national resources for science and technology	2,020	2,300	2,300
Program development and management	13,118	13,903	14,900
Allocations to other government agencies	167	177	0
Total	415,967	488,205	525,300

Derived from NSF "Summary of Budget Estimate for Fiscal Year 1967," U.S. Congress, House, Committee on Appropriations, Independent Offices Appropriations for 1967, Hearings, 89th Cong., 2d Sess., 1966, p. 107.

TABLE 27

PERCENTAGE DISTRIBUTION OF NATIONAL SCIENCE FOUNDATION FUNDS BY PERFORMANCE CATEGORY, FISCAL YEARS 1965, 1966, AND 1967

Category	Actual % FY 1965	Estimate % FY 1966	Estimate % FY 1967
Basic research and supporting facilities	50.2	50.6	52.8
Basic research project grants	28.7	32.7	35.2
National Research programs	10.1	7.7	6.4
Specialized research facilities and equipment	6.7	5.6	5.7
National research centers	4.7	4.6	5.5
Science education programs	28.9	25.8	26.6
Institutional science programs	14.5	17.6	15.2
Institutional grants for science	2.7	3.0	2.8
Graduate science facilities	5.2	6.4	3.8
Science development program	6.6	8.2	8.6
Science Information services	2.7	2.6	2.2
Studies of national resources for science and technology	.5	.5	.4
Program development and management	3.2	2.9	2.8
Total	100.0	100.0	100.0

Derived from NSF "Summary of Budget Estimate for Fiscal Year 1967," U.S. Congress, House, Committee on Appropriations, Independent Offices Appropriations for 1967, Hearings, 89th Cong., 2d Sess., 1966, p. 107.

(2) primarily for science education, and (3) for both research and education. Table 28 sets forth the Foundation's analysis of its programs in these terms. The Foundation estimated that for fiscal year 1967 about 42 percent of its budget would be spent primarily for basic research, about 28 percent for science education, and about 30 percent for both research and education combined. The Foundation recognizes that "the conduct of basic research and the training of scientists at the graduate and post-graduate levels are in practice inseparable."[1]

However, as the analysis set forth in Table 28 indicates, the Foundation does attempt to emphasize the educational facets of research more strongly in some programs than in others. As the following discussion indicates, the institutional science programs are generally designed to affect the development of a coherent relationship between research and science education activities sponsored by the Foundation at given institutions.

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[1] House, Committee on Appropriations, Independent Offices Appropriations . . . , p. 92.

TABLE 28

ESTIMATED DISTRIBUTION OF NATIONAL SCIENCE FOUNDATION BUDGET, FISCAL YEAR 1967, BY MAJOR PURPOSE
(in millions of dollars)

Activity	Budget Estimate	Primarily for Basic Research	Primarily for Science Education	Contributes to Both Research and Education
Basic research and facilities	276.9	188.6	-	88.3
Basic research project grants	185.0	110.0	-	75.0
National research programs	33.0	32.0	-	1.3
Specialized research facilities	30.0	18.0	-	12.0
National research centers	28.6	28.6	-	-
Science education programs	140.0	-	126.0	14.0
Fellowships and traineeships	48.0	-	34.0	14.0
Other science education programs	92.0	-	92.0	-
Institutional science programs	79.5	31.0	19.7	28.8
Institutional grants for science	14.5	5.0	4.7	4.8
Graduate science facilities	20.0	12.0	-	8.0
Science development program	45.0	14.0	15.0	16.0
Science information services	11.4	-	-	11.4
Studies of national resources for science and technology	2.3	-	-	2.3
Program development and management	14.9	-	-	14.9
Total	525.0	219.6	145.7	159.7

Source: U.S. Congress, House, Committee on Appropriations, Independent Offices Appropriations for 1967, Hearings, 89th Cong., 2d Sess., 1966, p. 93.

The Foundation's grants to institutions for research and related purposes take three primary forms: (1) grants for graduate science facilities, (2) grants of "free" funds distributed on a percentage basis, and (3) science development grants.

The Foundation's support of science facilities has taken two primary forms: (1) support of specialized research facilities through the regular research divisions of the Foundation for the purpose of increasing the resources available for research in specific disciplines and subject areas, and (2) support of graduate science facilities through the Division of Institutional Grants for the purpose of assisting the conduct of research and science education in a particular scientific discipline, or a combination of disciplines, at a specific university or college. The difference between these two types of grants are exemplified in the grant titles. For example, in 1965 the Specialized Research Facilities Support program funded such grants as the following: (1) University of Alabama, Robert D. Brown: Purchase of Calorimetry Equipment and a Preparative Gas

Chromatograph, $15,800, (2) University of Arkansas, Robert F. Kruh, Purchase of a Proton Magnetic Resonance Spectrometer, $21,500. In contrast, grants under the Graduate Science Facilities program included: (1) University of Arizona, Richard A. Harvill, Construction of a New Civil Engineering Building, $497,500, (2) University of Illinois, David D. Henry, Remodelling of Vivarium Building for Research in Bioenergetics, $15,375.[1]

The Foundation classifies the Graduate Science Facilities program as an institutional program, while it classifies the Specialized Research Facilities Support program as an adjunct of its support of basic research projects. The Graduate Science Facilities program more or less evolved out of the Specialized Research Facilities Support program, so the backgrounds of these programs can be analyzed together.

The Foundation's organic act authorizes it to support "basic scientific research," but does not specifically authorize it to make grants for scientific equipment and facilities. Nonetheless, the Foundation from its

[1]National Science Foundation, Grants and Awards 1965 (Washington: U.S. Government Printing Office, 1966), pp. 108-14.

inception has permitted the acquisition of equipment on project grant funds. The annual report for 1952 states that "The Foundation will not normally require that title to equipment purchased with granted funds vest in the Government; such equipment may thus be retained by the grantee. No accounting for equipment will be necessary."[1] In addition to the support of the acquisition of equipment through research project grant funds, the Foundation in 1953 made a research grant for partial support for the construction of a radio telescope at the Harvard College Observatory.[2]

In fiscal year 1956 the Foundation submitted to Congress an explicit request for funds for the support of research facilities, in conjunction with the support of basic research. This request was approved and since that year requests for funds for specialized research facilities and equipment have been a component of the Foundation's requests in the category "Basic Research and Supporting Facilities." In fiscal year 1965 the Foundation obligated $27,742,000 for specialized research facilities out of a

[1] National Science Foundation, Second Annual Report (Washington: U.S. Government Printing Office, 1953), p. 51.

[2] National Science Foundation, Third Annual Report (Washington: U.S. Government Printing Office, 1954), pp. 34-35.

total obligation of $208,887,000 for basic research and supporting facilities. The specialized research facilities accounted for 6.7 percent of total Foundation obligations made in 1965.

In fiscal year 1960 the Foundation requested and received an appropriation of $2 million to be used for the modernization of graduate laboratories,[1] and established the Graduate Facilities Program. As is indicated in Table 29, in the period 1960 to 1965 the Foundation made 789 grants under this program. These grants are classified as institutional grants because the grants are made to institutions for the purpose of strengthening general research and educational capacity in a specified science area. For these grants the institution must provide from non-federal sources matching funds equal to the amount provided by the Foundation. Despite the fact that the Office of Education under the Higher Education Act of 1963 now provides funds for the construction of academic facilities, the Foundation takes the position that support is necessary for graduate science facilities in addition to the support available from the Office of

[1] House, Committee on Appropriations, Independent Offices Appropriations . . . , p. 624.

TABLE 29

NATIONAL SCIENCE FOUNDATION PROGRAM OBLIGATIONS FOR GRADUATE SCIENCE FACILITIES, FISCAL YEARS 1960-1967 (in millions of dollars)

Fiscal Year	Amount of Obligations	Number of Grants
1960	2.1	a
1961	8.5	87
1962	26.0	325
1963	29.0	142
1964	30.0	130
1965	21.4	105
1966[b]	31.6	90
1967[b]	20.0	60

Sources: U.S. Congress, House, Committee on Science and Astronautics, The National Science Foundation: A General Review of Its First 15 Years, 89th Cong., 1st Sess., 1965, p. 164; Committee on Appropriations, Independent Offices Appropriations for 1967, Hearings, 89th Cong., 2d Sess., 1966, p. 267.

[a]Grants made in fiscal year 1961.

[b]Estimate.

Education. In fiscal year 1965 the Foundation initiated a two-phase granting procedure in this program. In the first phase, funds are provided for the design and planning of a facility. When the design and plans are approved by the Foundation, the second phase--payment by the Foundation of its share of the cost of construction--comes into operation. As is indicated in Table 30, the part of the total cost of the facility paid for by NSF is in many cases considerably less than 50 percent.

While the Graduate Science Facilities Program does contribute to the capacities of institutions to perform research and conduct graduate education and does help to spread Foundation funds among a large number of institutions, this program does not differ markedly from the facilities programs of the Office of Education, and does not constitute a significant divergence from basic administrative practices for funding research and related activities established in the early 1950's, particularly in that decision-making authority over the specific use of funds is still retained by the agency. While the Foundation does intend to continue

TABLE 30

ILLUSTRATIVE GRANTS UNDER THE NATIONAL SCIENCE FOUNDATION GRADUATE FACILITIES PROGRAM, FISCAL YEAR 1965

Institution	Total Cost of Facility	Portion Devoted Primarily to Graduate Science Facilities	Actual NSF Support Granted	NSF Support as Percent of Total Cost
Arizona State University	$1,804,900	$ 962,050	$ 481,025	27
Yale University	388,850	310,650	100,000	26
Colorado State University	635,100	630,000	315,000	50
Florida State University	121,000	107,200	53,600	44
Georgia Institute of Technology	1,377,500	711,500	355,750	26
University of Chicago	4,677,600	4,484,900	2,242,440	48
Louisiana State University	74,800	74,800	37,400	50
University of Massachusetts	563,400	441,700	127,375	23
University of North Carolina	1,851,000	1,552,900	714,700	39
Northwestern University	2,200,000	2,042,300	900,000	41
Mississippi State University	2,107,500	315,400	157,500	07
Dartmouth College	24,000	18,330	9,160	38
Ohio State University	16,600	16,600	8,300	50
Oklahoma State University	65,200	65,200	32,600	50
University of Rhode Island	402,000	390,000	100,000	25
Texas A&M University	350,900	346,300	173,150	49
University of Virginia	87,100	87,100	43,550	50
University of Washington	80,000	74,100	37,050	46

Derived from U.S. Congress, House, Committee on Appropriations, Independent Offices Appropriation for 1967, Hearings, 89th Cong., 2d Sess., 1966, Part 2, p. 268.

the Graduate Science Facilities Program in the future, it intends to restrict rather than to expand the program because the Office of Education has a related program covering all academic areas.[1]

As noted above in Table 29, the Foundation's budgetary estimates from this program declined from about $31 million for fiscal year 1966 to about $20 million for fiscal year 1967.

The second type of institutional program used by NSF is the institutional base program. This Program was created by the Foundation in July 1960 as a result of the growing realization by Foundation policy-making officials that project grant funds do not provide universities and colleges with the freedom to allocate funds to meet local requirements, both in terms of balancing support among science fields and in terms of meeting needs for different expenses such as staff salaries, travel expenses, and the like.[2]

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[1] See testimony of Leland J. Haworth in House, Committee on Appropriations, Independent Offices Appropriations . . . , p. 264.

[2] National Science Foundation, Eleventh Annual Report (Washington: U.S. Government Printing Office, 1961), p. 68. See also, J. Merton England, "Institutional Grants of the National Science Foundation," Science, CXLVIII, no. 3678 (1965), 1694.

In the Base Grant Program, funds are awarded once a year in response to an application from eligible institutions. Any institution that has received a grant for basic research from the Foundation, or participated in the Foundation's Undergraduate Research Participation Program, or Program of Research Participation for College Teachers, is eligible. While this is a formula program, since the formula is based on past participation in NSF programs the Base Grant Program does not serve as a mechanism for distributing funds to institutions that are not already heavily engaged in the performance of research. While the formula has varied somewhat over the years, the formula for computing the grants for fiscal year 1965 was: 100 percent of the first $10,000 of Foundation grants made for basic research and related science education projects; 10 percent of the amount from $10,001 to $1 million; 3 percent of the amount from $1,000,001 to $1,500,000; 1.5 percent of the amount from $1,500,001 to $2,000,000; 1 percent of the amount from $2,000,001 to $2,500,000; and 0.5 percent of the amount above $2,500,000. In fiscal

year 1965 institutional base grants totaling $11,417,659 were made to 376 colleges and universities. This constituted about 2.7 percent of total NSF obligations in 1965.

In the Base Grant Program, decision-making authority on the specific use of funds is left to the recipient institutions, with the qualification that the funds be used for science and not for indirect costs incurred in conjunction with other science grants. Each institution is required to submit an annual report setting forth the purposes for which the funds were used. The reports covering the use of grant funds from July 1, 1963 to June 30, 1964 indicated that the funds were used for the following purposes:

Purpose	Percent
Research and instructional equipment	45
Faculty research projects	15
Faculty salaries	10
Science library resources	9
Computer equipment and operations	7
Facilities	6

Student stipends	4
Miscellaneous items: travel, curriculum development, manuscript preparation, other	4

The Foundation proposes to expand the formula base for fiscal year 1967 to include research grants made by agencies other than the Foundation in the computation of awards. It does not propose, however, to increase the obligations under the Program in fiscal year 1967 over the estimated obligations for fiscal year 1966, $14,500,000.

The third major type of institutional grant used by NSF is the science development grant. In the words of a report issued by the Subcommittee on Science, Research and Development of the House Committee on Science and Astronautics:

> Of all the programs which the Foundation has initiated and supported to carry out the primary mission for the development and encouragement of the basic research and science education resources of the Nation, the science development program is unique.[1]

The Science Development Program was conceived in 1963 as a partial response to the President's Science Advisory Committee's report of November 15, 1960, Scientific

[1] House Committee on Science and Astronautics, Review of the National Science Foundation . . . , p. 169.

Progress, the Universities, and the Federal Government.[1]

This report asserted that:

> The growth of science requires more places with superior facilities and outstanding groups of students. Existing strong institutions cannot fully meet the nation's future needs. . . . We must hope that where there were only a handful of generally first-rate academic centers of science a generation ago and may be as many as fifteen or twenty today, there will be thirty or forty in another fifteen years. Timely and determined support to the rising centers will be repaid many times over in service to society.[2]

In response to this PSAC report and to its own evaluation of the needs of academic science, the Foundation in 1963 submitted a budgetary request for $33 million to undertake a program designed to assist potentially first-rate institutions in science to achieve the standing of centers of excellence in scientific research and teaching.[3] The House Independent Offices Appropriations Subcommittee was not receptive to the proposal, and in its Report stated:

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[1] President's Science Advisory Committee, Scientific Progress, the Universities, and the Federal Government (Washington: U.S. Government Printing Office, 1960).

[2] Ibid., p. 15.

[3] See U.S. Congress, Committee on Appropriations, Independent Offices Appropriations, 1964, Hearings, 88th Cong., 1st Sess., 1963, Part 2, p. 450.

> Funds are not recommended for any of the new programs proposed in the 1964 budget estimate. The Committee requests that no new programs be started.[1]

Neither the Senate Appropriations Committee report nor the appropriations legislation enacted for fiscal year 1964 mentioned the proposed program. However, in March 1964, the Foundation announced the creation of the program, entitled the Science Development Program.[2]

For fiscal year 1965 the Foundation requested $25 million for this program. This request was approved by the House Independent Offices Appropriations Subcommittee with the comment that:

> The Committee has specifically approved the $25,000,000 requested for developing centers of excellence in science and engineering. This program was initiated by the Foundation in 1964 and promises to be one of the best methods to truly broaden the development of scientific and engineering knowledge in every part of the Nation, particularly in those areas where assistance is needed most.[3]

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[1] U.S. Congress, House, Committee on Appropriations, Independent Offices Appropriations Bill, 1964, Report, 88th Cong., 1st Sess., 1963, p. 16.

[2] National Science Foundation Release, NSF 64-7, "Science Development Program for Colleges and Universities."

[3] U.S. Congress, House, Committee on Appropriations, Independent Offices Appropriations Bill, 1965, Report, 88th Cong., 2d Sess., 1964, p. 16.

The Science Development Program is based on the use of two different types of grants, composite grants and specific area grants. Composite grants are "found primarily on the achievement of a substantial and prompt improvement in a limited number of carefully selected institutions which have the potential to develop into outstanding centers for research and science education on a broad front."[1]

Specific area grants, on the other hand, are intended to assist an institution whose scientific programs are of medium quality to develop one excellent department. As of January 1, 1966, the specific area grant program was still in the planning stage. In early November 1966, the Foundation announced that it was dividing its Science Development Program into three component programs, a University Science Development Program, to consist of composite grants to help institutions that are potential centers of excellence in research and education to achieve comprehensive institutional excellence in science, a Departmental Science Development Program, to consist of specific area grants to selected departments to enable the departments

[1] National Science Foundation, "Justification of Estimates of Appropriations, Salaries, and Expenses, Fiscal Year 1967," in U.S. Congress, House, Committee on Appropriations, Independent Offices Appropriations for 1967, Hearings, 89th Cong., 2d Sess., 1966, p. 269.

to strengthen themselves, and a College Science Improvement Program to enable undergraduate institutions to accelerate the development of their science capabilities. This program is intended to aid activities at the undergraduate level calculated to improve the preparation of students for careers in science.[1]

As of January 1966, institutions applying for a composite grant were required to submit extensive information concerning their development plans, a requirement that has stimulated extensive self-examination on the part of many institutions. From March 1964 to January 1966, about 200 colleges and universities had conferences with Foundation officials, and 76 schools submitted detailed proposals setting forth the following information: (1) a five-year science development plan, including a statement of the institution's development plans in all areas in the five-year period; (2) the purposes for which the Foundation grant money would be used; (3) a budget for the five-year science development plan, including a statement of the contribution to be made by sources other than the Foundation.

[1]For a description of these programs, see "NSF Begins Two New Programs, Will Revise Another, Upgrading College, University Science," Higher Education and National Affairs, XV, No. 37 (November 4, 1966), 1-2.

From March 1964 to January 1966, the proposals were evaluated by Foundation officials with the assistance of an advisory panel consisting of the following members: Carl W. Borgmann, the Director of the Program in Science and Engineering of the Ford Foundation; Robert R. Brode, Professor of Physics, University of California, Berkeley; Dale R. Corson, Provost, Cornell University; Colgate, W. Darden, Jr.; James D. Ebert, Director of the Department of Embryology, Carnegie Institution of Washington; William B. Harrell, Vice President of Special Projects, University of Chicago; Lyle H. Lanier, Executive Vice President and Provost, University of Illinois; John R. Pierce, Executive Director of Research Communications, Bell Telephone Laboratories. This committee in turn draws on the advice of well-qualified people in industry, government, and universities.

The basic criteria used in evaluation of proposals are (1) the feasibility of the plan; (2) the quality of the existing scientific capacity of the institution; (3) the effectiveness of the institution's science programs in serving the needs of the region in which it is located,

and the needs of the region, and (4) the institution's ability to attract good students. From March 1964 to January 1966, the Foundation awarded 13 grants of a value of $47.3 million to the following institutions:

Washington University, St. Louis,	$3,919,000
Western Reserve University	3,500,000
Case Institute of Technology	3,500,000
University of Oregon	4,000,000
Rice University	2,390,000
University of Arizona	4,045,000
University of Southern California	4,473,000
The Polytechnic Institute of Brooklyn	3,332,000
Louisiana State University	3,787,000
University of Colorado	3,755,000
University of Rochester	2,550,000
University of Virginia	3,780,000
University of Florida	4,240,000

Of the $47.3 million total, $19.4 million, or 41 percent, were spent on salaries, including faculty, graduate students and non-academic salaries; $14.2 million, or 30 percent, were spent on facilities, and $13.7 million, or 29 percent, were spent on equipment. Table 31 sets forth the fields of science on which the funds were spent.

TABLE 31

EXPENDITURES OF NATIONAL SCIENCE FOUNDATION SCIENCE DEVELOPMENT PROGRAM FUNDS BY FIELD OF SCIENCE, MARCH 1964 TO JANUARY 1966

Field	Amount ($ millions)	Percent of Total
Astronomy	1.9	4.0
Biology	1.8	3.8
Chemistry	12.0	25.4
Engineering, including materials science	8.7	18.4
Geology	1.2	2.5
Mathematics	5.2	11.0
Physics	9.5	20.1
Social Sciences	1.0	2.1
Multidisciplines	6.0	12.7
Total	47.3	100.0

Source: National Science Foundation, "Justification of Estimates of Appropriations, Salaries, and Expenses, Fiscal Year 1967," in U.S. Congress, House, Committee on Appropriations, Independent Offices Appropriations for 1967, Hearings, 89th Cong., 2d Sess., 1966, p. 270.

The Foundation plans to make specific area, departmental development grants in early 1967. These grants will be designed to encourage the building of an institution's scientific competence around an existing department with an established scientific and engineering competence. Institutions with strong science departments, and recipients of composite grants, will not be eligible under this program. Grants will be made for a maximum period of three years at a maximum amount of $200,000 a year.

While not classified as an institutional program by the Foundation, the Graduate Traineeship Program is designed to involve recipient institutions in its administration. This program was initiated by the Foundation in fiscal year 1964 in response to the Gilliland report, a report issued by the President's Science Advisory Committee on December 12, 1962, entitled Meeting Manpower Needs in Science and Technology.[1]

This report recommended (1) that agencies cooperate in achieving an increase in the number of doctor's degrees awarded each year in engineering, mathematics and physical

[1]The President's Science Advisory Committee, Meeting Manpower Needs in Science and Technology (Washington: U.S. Government Printing Office, 1962).

sciences from 3,000 in 1960 to 7,500 in 1970; (2) that agencies encourage the strengthening of existing centers of excellence in science and engineering and the development of new centers of educational excellence; and (3) that agencies attempt to promote wide geographic distribution of centers of educational excellence.[1]

In funding graduate studies, the Foundation in the 1950's awarded fellowships primarily on the basis of national competition.[2] The Foundation found that the students who were offered fellowships tended to go to a small number of institutions with outstanding reputations. In instituting the Traineeship Program in 1964, a program limited in that year to engineering, the Foundation decided to grant funds to institutions with the capacity for expanding, and to allow the institutions to select the students. The basic objective of the Traineeship Program is to increase the number of qualified persons who begin and complete study leading to a master's or doctor's degree in science. As a means to this end, the program is designed to enable the institutions to attract good students.

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[1] See ibid., pp. 6-8.

[2] For an explanation of the Foundation's educational programs 1952-1960, see Waterman, "The National Science Foundation: a 10-Year Resumé," Science, CXXXI, 1341.

The proposal for a graduate traineeship grant must originate in a department or comparable unit of a university. All proposals from departments within a given institution are evaluated together, and a single grant is made to the institution, with specifications on how the traineeships awarded are to be distributed among disciplines within the institution. However, the institution is authorized to redistribute up to 25 percent of the traineeships among disciplines as it thinks best, and may apply for up to three unspecified traineeships. A minimum of 80 percent of students supported under traineeships must be first-year students, in the case of an initial traineeship grant. However, in the subsequent years of a grant, students beyond the first year may be supported. Grants, which generally are for four years, are progressively decreased in amount in the expectation that the grantee institution will provide support for some students beyond the first year. As in many other Foundation programs, awards are made in part on the basis of the recommendation of advisory panels. However, in this program the Foundation explicitly

states that it seeks "an appropriate distribution of National Science Foundation traineeships among the various disciplines and the various regions of the United States."[1]

The Foundation sees this as a significant program in that it is responsive to some degree to demands for an "equitable" distribution of research-related funds, and in that it involves university administrative personnel in the planning of institutional development. In this aspect the program is similar to the Institutional Base Grant Program and the various Science Development Programs described above. Table 32 sets forth the obligations under this program for fiscal years 1965, 1966, and 1967.

The National Institutes of Health

Like the National Science Foundation, the National Institutes of Health have relied predominately on the project grant mechanism for the funding of academic research. As is indicated in Table 33, in fiscal year 1965 NIH obligated $652,421,000 to universities and colleges. Of this $652 million, $422 million, or 65 percent, were allocated to research and development activities; $217 million, or

[1] House, Committee on Appropriations, Independent Offices Appropriations . . . , p. 214.

TABLE 32

OBLIGATIONS FOR NATIONAL SCIENCE FOUNDATION GRADUATE TRAINEESHIP PROGRAM, FISCAL YEARS 1965, 1966 AND 1967

	Fiscal Year		
	1965	1966	1967
	Actual	Estimate	Estimate
Total	$15,060,889	$22,348,250	$27,361,300
New grants	9,625,903	11,109,500	9,878,800
Continuation of grants	5,434,987	11,238,750	17,482,500
Number of trainees	2,784	4,150	5,040
Under new grants	1,859	2,125	1,890
Under continuation	925	2,025	3,150
Cost per trainee	5,410	5,385	5,429
Under new grants	5,178	5,228	5,228
Under continuation	5,876	5,550	5,550

Source: National Science Foundation, "Justification of Estimates of Appropriations, Salaries, and Expenses, Fiscal Year 1967," in U.S. Congress, House, Committee on Appropriations, Independent Offices Appropriations for 1967, Hearings, 89th Cong., 2d Sess., 1966, p. 213.

33 percent were allocated to other science activities, primarily training grants, fellowships, and general research support grants, and about $13 million, or 2 percent, were obligated to undergraduate training grants. Fifty-one percent of all NIH obligations to universities and colleges was obligated for specific research projects, while an additional 13 percent was obligated for related research resources consisting primarily of equipment, and research and development plant. Training grants constituted 22 percent of total NIH obligations to universities and colleges, while fellowships comprised 6 percent. Only 5 percent of NIH total obligations were obligated to general research support. However, NIH obligations for research resources, research facilities, training grants, and general research support grants together constituted about 40 percent of total NIH obligations to universities and colleges in fiscal year 1965.

NIH officials regard general research support grants as the primary type of NIH support that is explicitly designed to give educational institutions a measure of

TABLE 33

NATIONAL INSTITUTES OF HEALTH OBLIGATIONS TO UNIVERSITIES AND COLLEGES, BY TYPE, FISCAL YEAR 1965
(amounts in thousands)

Type of Support	Amount	Percentage of	
		Total Support	This Type of Support
Total	$652,421	100	-
Research and development	422,048	65	100
R and D conduct	367,298	56	87
Research projects	333,675	51	79
Research resources	33,623	5	8
R and D plant	54,750	8	13
Other science activities	217,611	33	100
Training grants	141,261	22	65
Fellowships	41,252	6	19
General research support grants	33,500	5	15
Other	1,598	-	1
Undergraduate training grants	12,762	2	100

Source: National Institutes of Health, Resources Analysis Branch, Office of Program Planning, NIH Obligations to Institutions of Higher Education Fiscal Year 1965, Part I, p. 2, Table 1.

autonomy and freedom in determining the character and direction of their research activities. NIH takes the position that up to 1962, the year in which the general research support program was initiated,

> In large part the support of research exclusively through the project system had deprived educational institutions of a large measure of autonomy and freedom in determining the character and direction of their research activities. Furthermore, exclusive reliance upon the project system did not make it possible for educational institutions to assume a position of responsibility in carrying out their role in the conduct of health-related research supported through Federal funds.[1]

The history of NIH's support of academic research, and the development of the general research support program can be summarized as follows.

Support of biomedical research in private institutions by federal agencies has for the most part

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[1]Statement of Thomas J. Kennedy, Chief, Division of Research Facilities and Resources, National Institutes of Health, in U.S. Congress, House, Committee on Appropriations, Departments of Labor and Health, Education, and Welfare Appropriations for 1967, Hearings, 89th Cong., 2d Sess., 1966, Part 4, p. 230 (hereafter cited as House Committee on Appropriations, Departments of Labor and Health, Education, and Welfare Appropriations, 1967 . . .).

materialized since 1940.[1]

As Table 34 indicates, in 1940 federal funds constituted only about 7 percent of funds for medical research in the United States. By 1947, the percentage had risen to 31 percent. A decade later, in 1957, federal funds

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[1]While no complete history of federal support of biomedical research is presently available, various aspects of this history are traced in the following works: Ralph Chester Williams, The United States Public Health Service, 1798-1950 (Washington: U.S. Government Printing Office, 1951); Donald C. Swain, "The Rise of a Research Empire: NIH, 1930 to 1950," Science, CXXXVIII (December 14, 1962), 1233-1237; National Science Foundation, Medical Research Activities of the Department of Health, Education, and Welfare (Washington: U.S. Government Printing Office, December, 1955); Department of Health, Education and Welfare, The Advancement of Medical Research and Education Through the Department of Health, Education, and Welfare, Report of the Secretary's Consultants on Medical Research and Education, June 27, 1958; Public Health Service, National Institutes of Health, A Study of Twenty Medical Schools, April, 1959; U.S. Congress, Senate, Committee on Appropriations, Federal Support of Medical Research, Report of the Committee of Consultants on Medical Research to the Subcommittee on Departments of Labor, and Health, Education, and Welfare, May 1960; U.S. Congress, House, Committee on Interstate and Foreign Commerce, Medical and Dental Schools, Hearings, 86th Cong., 2d Sess., June 6, 1960; Biomedical Science and Its Administration, A Study of the National Institutes of Health, A Report to the President, February, 1965 (Washington: U.S. Government Printing Office, 1965); James A. Shannon, "Science and Federal Programs: The Continuing Dialogue," Science, CXLIV (1964), 976-78; National Academy of Sciences, National Research Council, The General Research Support Program of the National Institutes of Health (Washington: National Academy of Sciences, March 31, 1965).

TABLE 34

SOURCES OF FUNDS FOR MEDICAL RESEARCH, SELECTED YEARS, 1940-1964
(amounts in millions)

	1940		1947		1957		1963		1964	
	Amount	% of Total	Amount	% of Total	Amount	% of Total	Amount	% of Total	Amount	% of Total
Federal funds	3	6.6	27	31.0	229	52.0	973	64.1	1,049	63.5
Intramural	2	4.4	17	19.5	90	20.5	255	16.8	N.A.	-
Extramural	1	2.2	10	11.5	139	31.5	718	47.3	N.A.	-
Non-federal	42	93.4	60	69.0	211	48.0	546	35.9	603	36.5
Total	45	100.0	87	100.0	440	100.0	1,519	100.0	1,652	100.0

Sources: National Academy of Sciences, National Research Council, The General Research Support Program of the National Institutes of Health (Washington: National Academy of Sciences, March 31, 1965), p. 5; and U.S. Congress, House, Committee on Appropriations, Departments of Labor and Health, Education and Welfare Appropriations for 1967, Hearings, 89th Cong., 2d Sess., 1966, Part 4, p. 179.

constituted 52 percent of total support of medical research in the United States, while in 1964 the figure was 64 percent.

Since the early 1950's NIH has consistently provided from 60 percent to 70 percent of total federal support of medical research. In 1963, for example, NIH provided $566 million of a federal total of $918 million. In 1965, NIH provided $715 million of a federal total of $1,175 million, while for 1966 the estimate was that NIH would provide $808 million of a federal total of $1,364 million.[1] In the 1950's, NIH supplemented its project support of academic science through a variety of programs relating to training, fellowships, and grants for research facilities. As a committee of the National Academy of Sciences has pointed out, however,

> All these programs . . . are centrally administered somewhat after the fashion of project grants. Many students of the problem are persuaded that the programs are not well designed to fill categories of need that can be more wisely evaluated at the institutional rather than the national level.[2]

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[1] House, Committee on Appropriations, Departments of Labor and Health, Education, and Welfare Appropriations . . . , Part 4, p. 180.

[2] National Academy of Sciences, National Research Council, The General Research Support Program of the National Institutes of Health (Washington: National Academy of Sciences, March 31, 1965), p. 7.

Two reports prepared in 1958, and another report prepared in 1960 laid the foundation for a 1960 amendment of the Public Health Service Act,[1] authorizing the Surgeon-General to make grants-in-aid to universities, hospitals, laboratories and other institutions for the general support of research and research training programs. The first of these reports by the Health, Education, and Welfare Secretary's consultants on medical research and education stated that:

> An increase in the capacity of research and educational institutions to perform their educational and research functions more effectively would be in the national interest. To this end, Federal funds for research should be provided under conditions which give the institutions a substantial degree of freedom in deciding how to use the funds. The essential function of such funds is to foster freedom and responsibility in the institutions.[2]

The second 1958 report, Strengthening American Science, by the President's Science Advisory Committee, also recommended the selective use of institutional grants for specialized fields in the interest of strengthening

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[1] Public Law 86-798, 86th Cong., September 15, 1960.

[2] The Advancement of Medical Research and Education, Final report of the Secretary's consultants on medical research and education, Office of the Secretary, Department of Health, Education and Welfare, June 27, 1958, p. 8.

the control by institutions of their own development.[1]

Finally, in May, 1960, a Committee of Consultants on Medical Research concluded:

> The support of investigators by a Federal agency on an individual project basis, after review and approval by committees of experts, has been outstandingly successful and has been carried on with great wisdom and flexibility. This support, however, comes to the schools and research institutions through requests of individual investigators without regard for the over-all plans of the institution and with conditions attached which may not fit into its programs. This can lead to an uneven development which may not be in the best interests of the institution as a whole.[2]

The committee concluded that the Public Health Service should be authorized by law to make grants to institutions for the general support of the institutions, health-related research and educational programs. After hearings on this and related matters,[3] Congress on September 15, 1960, amended the Public Health Service Act,[4] to provide

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[1] President's Science Advisory Committee, Strengthening American Science (Washington: U.S. Government Printing Office, 1958), p. 33.

[2] U.S. Congress, Senate, Committee on Appropriations, Report of the Committee of Consultants on Medical Research of the Subcommittee on Departments of Labor, and Health, Education and Welfare, 86th Cong., 2d Sess., 1960, p. 15.

[3] U.S. Congress, House, Committee on Interstate and Foreign Commerce, Medical and Dental Schools, Scholarship, Construction Grants, and Institutional Research Grants, Hearings, 86th Cong., 2d Sess., 1960.

[4] Public Law 86-798, 86th Cong., September 15, 1960.

funds for the general support of research and research training programs in an amount not exceeding 15 percent of the total funds available to NIH for grants for research and for research training projects.

As is indicated in Table 35, in the first year in which grants were made under the General Research Support Program, 1962, a total of $20 million was awarded to 153 institutions. This $20 million constituted 5.6 percent of total NIH research grant funds. In 1965, about $44 million were awarded to 264 institutions. This $44 million comprised 8.7 percent of total NIH research grant funds for that year. NIH has been strongly urged to allocate more funds to the General Support Program to bring the amount allocated to the program to the currently authorized level of 15 percent of the amounts provided for grants for research and research training projects.[1]

In its examination of the General Research Support Program undertaken in 1964 and 1965, a Medical Science Committee of the National Research Council concluded:

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[1] U.S. Congress, Senate, Committee on Appropriations, Department of Labor, and Health, Education, and Welfare, and Related Agencies Appropriations Bill, 1964, Report, 88th Cong., 1st Sess., 1964, p. 33; Biomedical Science and Its Administration, A Report to the President (Washington: U.S. Government Printing Office, 1965).

TABLE 35

NATIONAL INSTITUTES OF HEALTH, GENERAL RESEARCH SUPPORT PROGRAM OBLIGATIONS, 1962-1965
(amounts in millions)

Year	Obligations	Number of Institutions	Percentage of Total NIH Research Grant Funds
1962	$20	153	5.6
1963	30	264	7.0
1964	35	262	7.3
1965	44	264	8.9

Source: National Academy of Sciences, National Research Council, The General Research Support Program of the National Institutes of Health (Washington: National Academy of Sciences, National Research Council, 1965), p. 32.

> The Committee believes that institutions could effectively use substantially larger funds than are now available in the General Research Support Program and recommends that these be increased rapidly toward the authorized level of 15 percent of the "amounts provided for grants for research as research training projects." Moreover, unless the National Institutes of Health are able to launch a separate program for the long-term support of "key personnel," the need for substantial increases in awards will become progressively more urgent if the ability of institutions to respond to the changing demands for general research support is not to be improved.[1]

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[1] National Academy of Sciences, National Research Council, The General Research Support Program of the National Institutes of Health (Washington: National Academy of Sciences, National Research Council, 1965), p. 34.

NIH began to plan an expansion of the General Research Support Program in 1965. The initial grants under the program, made in 1962, were limited to schools of medicine, dentistry, osteopathy, and public health. These schools are automatically eligible for support, and grants are made on a formula basis. The formula is based on a grant of a base sum, supplemented by (1) a percentage of the total health-related research expenditures of a recipient institution in its latest complete fiscal year, up to a stated maximum, sponsored by federal research grants and contracts, and (2) a percentage of the total health-related research expenditures of the recipient institution in its latest complete fiscal year, up to a given maximum, sponsored by non-federal grants, contracts and gifts restricted for health-related research.

In 1963 the program was extended to schools of pharmacy and veterinary medicine, and to hospitals and non-academic research organizations. It was not extended to graduate departments of biological and other health-related sciences. With the extension of the program in

1963, the formula was supplemented with criteria that apply to institutions other than the four classes of health professional schools originally eligible. These criteria provide that the applicant must have received research of at least $100,000 in NIH research project grants during the prior fiscal year. The applicant also is required to submit data on the nature of its health-related expenditures in the previous year, and to indicate the purposes for which the funds requested will be used.

The NIH policy statement on the General Research Support Program gives the following examples of the way in which funds may be used: (1) support of research, particularly support of promising ideas that require further exploration and development prior to more formal consideration for project support; (2) studies of institutional long-range goals for research and research training; (3) support of collaboration between relatively distant research disciplines; (4) provision of stable salary support for key staff whose salaries might otherwise

be dependent on individual research grants or other unstable sources; (5) operation of central research resources, such as computers or animal facilities, not solely related to anyone specific project or program; and (6) provision of ancillary research services. The policy statement specifically provides that "the General Research Support Grant may not be used for the costs of new construction, alteration, or renovation."[1]

In 1964, a General Research Support Scientific Advisory and Review Committee was established to evaluate applications under the program. In addition to its general function of judging applications, the committee conducts site visits to applicant and grantee institutions, and attempts to assess the needs of institutions for general research support, and the advantages and disadvantages to NIH in funding research through general research support programs.

Grantee institutions are required to submit an annual report indicating the ways in which general support funds are spent and the administrative methods used to

[1]National Institutes of Health, General Research Support: A General Policy and Information Statement, revised September, 1963.

allocate the funds and ensure responsibility in their use. The financial aspects of these reports, as well as of the applications, are subject to audit by the Department of Health, Education, and Welfare Audit Agency. Data for fiscal years 1962-1965 derived from the annual reports submitted by schools of medicine, the class of institutions that receives the largest portion of the funds, indicate that funds were spent in the following general categories:[1]

	Percent
Salaries	54
Permanent Equipment	23
Research Trainees	11
Supplies	9
Travel	1
Other	2
Total	100

The reports for 1964 indicate that grantee institutions used the following methods to allocate general research support funds within the grantee institutions.[2]

Judgment by	Number of Institutions
Dean	8
Project Director	8
Faculty Scientific Review Committee	246
Total	262

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[1] House, Committee on Appropriations, Departments of Labor and Health, Education, and Welfare Appropriations . . . , Part 4, p. 234.

[2] Ibid.

In its analysis of the General Research Support Program, the Medical Sciences Committee of the National Research Council stated that:

> The outstanding conclusion that may be drawn from an analysis of the uses to which GRS funds have been put is the wide variability in the judgments of institutions as to their prime needs and opportunities for the strengthening of their research efforts. These judgments clearly reflect wide differences in local situations. As one reads the individual reports, the impression grows that one is reading a series of case histories of institutions, each with its own disabilities and complaints that call for individual treatment. It is scarcely conceivable that any form of centrally administered treatment could minister effectively to these needs. If this is a valid conclusion, it provides the most powerful argument for delegating some responsibility for self-treatment to the institutions in need.[1]

NIH officials are convinced that the General Research Support Program has thus far been a successful one, and are now extending NIH's general research support activities through two new programs, a Biomedical Sciences Support Program and a Health Sciences Advancement Support Program.

The Biomedical Sciences Support Grant Program is designed to extend general research support to academic

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[1]Emphasis in original. National Academy of Sciences, National Research Council, The General Research Support Program of the National Institutes of Health, p. 31.

units other than health professional schools. The logic underlying this move is that approximately one-half of the scientific manpower possessing doctoral degrees engaged in health-related research receives research training in university graduate schools, rather than in medical and other health professional schools, and the future of medical research is expected to depend heavily on Ph.D.'s trained in university science disciplines that are complementary to the traditional medical sciences. Like the General Research Support Program, the Biomedical Program is designed to place major responsibility for decision making over the use of funds with the institution receiving the funds. Like the General Research Support Program, the Biomedical Program will benefit most the schools that receive the largest amounts of project grant funds. The program is not designed to benefit weaker institutions.

In contrast, the Health Sciences Advancement Support Program is designed to advance the competence of institutions to perform biomedical research. This

program is described by NIH officials as "similar to the National Science Foundation's institutional development program, but . . . for the development of biomedical research competence."[1] This program was in the planning stages in March, 1966. Its creation was in part prompted by the Report of the Senate Committee on Appropriations for Fiscal Year 1965, which stated that NIH should use a portion of general research support funds for the purpose of enabling developing institutions to improve their health-science activities. The program is being designed to enable a small number of carefully selected institutions to advance to new levels in the performance of research and research training in the health sciences. Emphasis will be placed on aiding new and emerging schools to establish high quality research programs, particularly health professional schools.

Table 36 sets forth NIH's budgetary estimates for the three institutional support programs, General Research Support, Biomedical Sciences Support, and Health Sciences Advancement Support, for fiscal years 1966 and 1967.

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[1]Statement of Thomas J. Kennedy, Jr., Chief, NIH Division of Research Facilities and Resources, in House Committee on Appropriations, Departments of Labor and Health, Education, and Welfare Appropriations . . . , p. 237.

TABLE 36

BUDGETARY ESTIMATES FOR NATIONAL INSTITUTES OF HEALTH INSTITUTIONAL SUPPORT PROGRAMS, FISCAL YEARS 1966 AND 1967
(amounts in thousands)

Program	1966 Estimate		1967 Estimate	
	Number of Institutions	Amount	Number of Institutions	Amount
General Research Support	289	$39,200	295	$41,700
Educational institutions				
Dentistry	49	2,319	49	2,468
Medical	90	22,395	90	23,769
Osteopathy	5	161	5	171
Public health	12	1,688	12	1,797
Pharmacy	8	405	9	475
Veterinary medicine	12	1,173	12	1,248
Nursing	2	60	2	64
Non-educational institutions				
Hospitals	63	5,891	65	6,271
Research foundations	46	4,802	49	5,111
Health departments	2	306	2	326
Biomedical Science Support	85	5,000	100	6,000
Health Sciences Advancement Awards	4	1,000	7	4,000
Total	378	45,200	402	51,700

Source: U.S. Congress, House, Committee on Appropriations, Departments of Labor and Health, Education, and Welfare Appropriations for 1967, Hearings, 89th Cong., 2d Sess., 1966, Part 4, p. 240.

In addition to General Research Support Grants, NIH has also experimented with other types of support which place responsibility on the institution that does the project grant--advisory panel mechanism. Two of these types of support will be briefly considered, the Research Career Program and the Regional Medical Program.

The Research Career Program was established in fiscal year 1961, and the first grants under the program were made in fiscal year 1962. The purpose of the program is to increase the number of full-time career opportunities for scientists of superior capability in sciences related to health.[1]

Initially, two types of awards were made under the program, Career Awards and Career Development Awards. Career awards were somewhat similar to the endowment of research chairs by private donors, in that they were intended to enable an institution to provide stable support to an outstanding researcher for the duration of his career. These awards were intended to support established researchers of the highest competence. This type of award

[1]See National Institutes of Health, "Policies Governing the Research Career Program of the National Institutes of Health," January 1, 1963.

was discontinued as of July 30, 1964, in part because NIH officials concluded that there is a greater need for the support of potential investigators than for the support of established researchers who have relatively easy access to project grant funds.[1]

The second type of grant under this program is the Career Development Award. These awards are intended to enable institutions to finance research positions for investigators who have had three or more years of post-doctoral research experience. The awards are intended to apply to scientists in two categories: (1) Those who require addition training and experience to complete preparation for a career of independent research, and (2) Those who are engaged in independent research but have not achieved the level of productivity necessary to establish themselves as investigators of high competence.

From 1962 to 1965, NIH made 3,813 awards for $66,380,742 under these two programs. About $22,500,000 were obligated under this program in 1965. The estimate for 1966 was $27,500,000, and for 1967, $30,375,000.

[1] See U.S. Congress, House, Committee on Interstate and Foreign Commerce, Investigation of HEW, Report of the Special Subcommittee on Investigation of the Department of Health, Education, and Welfare, 89th Cong., 2d Sess., 1966, pp. 123-25.

Grants under the Research Career Program are made by the nine categorical institutes of NIH. The award instrument stipulates that the awardee is directly responsible to his university or college. The awardee's salary and title are established by the university or college. The salary cannot exceed $25,000, and is required by NIH to be consistent with the institution's established salary structure. The awardee is required by NIH regulations to devote the major portion of his time to research, although incidental participation in teaching and related activities is permitted. The awardee is not permitted to receive additional income from his institution or any other source. The awards are for five years, and are renewable for one additional five-year period. The grantee institution is required to submit an annual report of the awardee's activities and of expenditures under the grant.

At the request of a Subcommittee on Investigation of the Department of Health, Education, and Welfare of the House Committee on Interstate and Foreign Commerce, the General Accounting Office in 1965 reviewed the awards

made under this program to six institutions.[1] The General Accounting Office found that many of the awardees and their institutions were not complying with NIH requirements regarding salary limitations, restrictions on activities other than the performance of research, record keeping, and related matters. The Special Subcommittee on the Investigation of HEW concluded that NIH should revise its policies governing the Research Career Program to clarify the responsibilities of the institutions and the awardees under the program.

The Regional Medical Program is another program that delegates decision-making responsibility over the specific expenditure of funds to local institutions.

The Regional Medical Program is another program that delegates decision-making responsibility over the specific expenditure of funds to local institutions. This is not a research program as such. The purposes of the program are set forth in the statute[2] under which it

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[1]The report of the General Accounting Office is set forth, in part, in Appendix G-6 of U.S. Congress, House, Committee on Interstate and Foreign Commerce, op. cit., pp. 117A-124A.

[2]Heart Disease, Cancer, and Stroke Amendments of 1965, P.L. 89-239, October 6, 1965, 79 Stat. 926, 5 U.S.C.A. 757, 790, 800; 33 U.S.C.A. 763c; 42 U.S.C.A. 201 notes, 211a, 212a, 214 note, 222 note, 299-299i.

was created as follows:

> (a) Through grants, to encourage and assist in the establishment of regional cooperative arrangements among medical schools, research institutions, and hospitals for research and training (including continuing education) and for related demonstrations of patient care in the fields of heart disease, cancer, stroke, and related diseases;
> (b) To afford to the medical profession and the medical institutions of the Nation, through such cooperative arrangements, the opportunity of making available to their patients the latest advances in the diagnosis and treatment of these diseases; and
> (c) By these means, to improve generally the health manpower and facilities available to the Nation . . .

The legislation creating this program resulted from the recommendations of the President's Commission on Heart Disease, Cancer, and Stroke, which was established in 1964 to recommend steps to facilitate more effective use of medical knowledge that already exists. The Commission found that there is a gap between the diagnositc and therapeutic capabilities of many major research centers. In other terms, the results of research have not always been translated into actual care of patients as regularly as may be possible. The Regional Medical Program is designed

to close this gap by promoting closer cooperation among the medical schools, research institutions, hospitals and doctors in a given region. A Division of Regional Medical Programs was established by NIH in 1965 to lay the foundations of the program. Twenty-five million dollars were approximated for the program for fiscal year 1966, and $45 million for fiscal year 1967. No grants had been made as of April 1966, but a number of tentative applications had been received and awards were planned for the summer and fall of 1966. Universities, medical schools, research institutions and public or private health agencies are eligible to apply under the program. The applicant must designate an advisory group to assist in the planning and operation of a regional medical program. The advisory group must be composed of representatives of the major health organizations in the region defined in the application. The guidelines for the program define a region as "a geographic area which forms an economic and socially related region, taking into consideration such factors as present and future population trends and patterns of growth;

location and extent of transportation and communication facilities and systems; and presence and distribution of educational, medical, and health facilities and programs."[1]

The initial grants under the program will be planning grants to provide an opportunity for the health institutions within a region to study the region's medical needs, and to devise a substantive program to meet those needs. NIH anticipates great diversity in the substantive programs created by different regions because of diversities in regional needs, resources, and existing medical patterns.

The Regional Medical Program is a distinctive one in two respects. It is specifically addressed to the problem of putting the results of research into practice, a problem that has arisen in connection with many federally sponsored research activities in the 1960's. The program also is distinctive in that it is specifically directed to the satisfaction of regional needs. In these two respects the program exemplifies two of the most important pressures of the total federal academic research funding

[1]House, Committee on Appropriations, Departments of Labor and Health, Education, and Welfare Appropriations . . . , p. 539.

system in the 1960's, the pressure for getting greater civilian benefits out of federal research funds, and the pressure for spreading the benefits derived from federal research funds on an "equitable" basis throughout the country.

The National Aeronautics and Space Administration

Like NSF and NIH, the core of NASA's support of university activities consists of support of traditional research projects. In fiscal year 1965, NASA's obligations to universities took the following forms:[1]

	$ Millions
Research support	66.3
Satellite instrumentation	17.2
Tracking and data acquisition	1.6
Research facilities	8.4
Training of students	24.5
Technology utilization	2.2
Miscellaneous	.9
Total	121.1

The distinctive element in NASA's support of research and related activities has been the Sustaining University

[1] U.S. Congress, House, Committee on Science and Astronautics, 1967 NASA Authorization, Hearings before the Subcommittee on Space Science and Application, 89th Cong., 2d Sess., 1966, p. 562.

Program.[1] This program is designed to strengthen universities while concurrently promoting the progress of space science. Specifically, it has the following objectives:

> (1) The predoctoral training of scientists and engineers in space-related science and technology . . .
>
> (2) Assistance in the acquisition of adequate, graduate space research facilities at institutions whose participation in NASA programs has generated critically crowded conditions . . .
>
> (3) The development of new or unrecognized capabilities, consolidation of space-oriented research activities, and the encouragement of multi-disciplinary investigations . . .[2]

The Sustaining University Program is an integrated program of training, research, and facility construction. The program was created through NASA's own initiative in 1962, and since that year has constituted from 30 to 40 percent of NASA's total funding of university activities. In fiscal year 1965 the funds obligated through this program totaled $45.2 million, or 37.3 percent of NASA's total

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[1] For a comprehensive description of this program, see National Aeronautics and Space Administration, NASA University Program Review Conference (Washington: U.S. Government Printing Office, 1965).

[2] Committee on Science and Astronautics, 1967 NASA Authorization, p. 561.

obligations to universities. Of the $45.2 million, $24.5 million were obligated for training, $12.3 million were obligated for research support, and $8.4 million were obligated for research facilities. The training element of the program is designed to produce 1,000 Ph.D.'s a year in the physical sciences, engineering, and related areas. To achieve this goal, 1,335 new NASA trainees have been supported each year. Each trainee is assured of 3 years of support, if he attends school on a year-round basis. In September 1966, 3,681 students were supported through the program at 152 institutions. As of March 1966, 104 Ph.D.'s had been awarded through this program, of whom 65 were employed by universities, 20 were employed by industry, 15 were pursuing postdoctorate studies, and 4 were employed in government laboratories.

The research component of the Sustaining University Program differs from the project grant method of funding research in three respects: (1) grants are made to institutions, rather than to individual researchers, although a named individual in each institution is the

legal grantee of the funds; (2) grants are made for work in broad interdisciplinary areas of inquiry, in which the investigators have considerable flexibility over the decision of the specific research conducted; and (3) grants in many cases are made to institutions on the basis of the desire of the institutions to develop new capabilities. Grants are made to institutions on the basis of negotiations between institutional representatives and NASA's office of grants and research contracts. While grants are not made on a formula basis, the regional location of institution is considered in making grants. In fiscal year 1965, the NASA Sustaining University Program research dollars per capita to the major census regions in the United States ranged from a low of .23 in the East-South Central Region--Kentucky, Tennessee, Alabama, and Mississippi--to a high of .78 in the Pacific Region--Washington, Oregon, California, Alaska, and Hawaii. As of 1966, research grants for the purpose of enabling institutions to develop new capabilities had been made to the following universities: Adelphi; Alabama; Brown;

Denver, Duke; Florida; Graduate Research Center of the South West; Georgia Institute of Technology; Kansas; Kansas State; Louisville; Maine; Maryland; Missouri; Montana State College; New Mexico State: Oklahoma State; Pittsburgh; Southern Methodist; Texas A&M; Vermont; Virginia; Virginia Polytechnic Institute; Washington (St. Louis); West Virginia; and William and Mary. In addition, the following institutions were awarded grants intended to strengthen their effectiveness and productivity in space research: University of California (Berkeley); University of California (Los Angeles); California Institute of Technology; Massachusetts Institute of Technology, Minnesota; New York University; Pennsylvania; Pennsylvania State; Purdue, and Wisconsin. As of January 1, 1966, grants ranged in size from a grant of $42,000 for research in space physics to Harvard University, to a grant for $1 million to Massachusetts Institute of Technology for multi-disciplinary research in space-related physical, engineering, social, and life sciences.

While the Sustaining University Program is an

innovative one, its funding level of about $40 million is small in relation to the total of federal funds obligated to universities by federal agencies. However, the pattern exemplified in it may be followed by other mission-oriented agencies in the future.

In addition to the Sustaining University Program, NASA has initiated another program of potentially great significance--the Technology Utilization Program.[1] Under this program NASA has established at several universities selected on a region basis, Regional Dissemination Centers the purpose of which is to promote the transfer of technology among federal agencies, universities, and industries. As the demand for the application of science to social problems grows more intense, as the analysis in Chapter IV indicates that it will, the Technology Utilization Program may also become more important. As is indicated below, there is a general belief that the whole process of technology transfer is in a rudimentary state of development,[2]

[1] See National Aeronautics and Space Administration, NASA's Technology Utilization Program (Washington: U.S. Government Printing Office, 1965); Transforming and Using Space-Research Knowledge (Washington: Clearinghouse for Federal Scientific and Technical Information, 1964).

[2] In general, see U.S. Department of Commerce, Technology Transfer and Innovation: A Guide to the Literature (Washington: Clearinghouse for Federal Scientific and Technical Information, 1966).

and could become a critically important element of federal policy in the future.

Summary

In summary of this chapter, four major decision-making patterns have been developed for the purpose of funding academic research by federal agencies: the state formula pattern, the procurement pattern, the project grant pattern, and the institutional pattern. The next chapter examines demands for changes in these funding patterns.